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THE

# VOYAGE OF H.M.S. CHALLENGER.

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## ZOOLOGY.—VOL. II.

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# REPORT

ON THE

## SCIENTIFIC RESULTS

OF THE

# VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

CAPTAIN FRANK TURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

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DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

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# CONTENTS.

I.—Report on certain Hydroid, Alcyonarian, and Madreporarian Corals procured during the Voyage of H.M.S. Challenger, in the years 1873–1876.

By H. N. Moseley, M.A., F.R.S., Fellow of Exeter College, Oxford, late Member of the Civilian Scientific Staff of the Challenger Expedition.

(*Received November* 17, 1879.)

II.—Report on the Birds collected during the Voyage of H.M.S. Challenger, in the years 1873–1876.

By Philip Lutley Sclater, M.A., Ph.D., F.R.S., F.L.S, F.G.S., F.R.G.S., Secretary to the Zoological Society of London.

(*Received April* 9, 1880.)

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# NOTICE.

THE two Memoirs which form this volume will be widely separate from one another in the final collation.

A considerable part of Mr Moseley's Report on the special groups of Corals and coral-building polypys, to which he had mainly devoted his attention, was prepared during the voyage of the CHALLENGER, and, from the great interest which appeared to me to attach to his investigations on the Helioporidæ and on the structure of *Millepora*, and of other Hydroid forms, I was glad to have it in my power to sanction the publication of two papers on these subjects in the Philosophical Transactions for the years 1876 and 1877, in anticipation of the Official Report of the Expedition. In 1878 Mr Moseley was selected by the Council of the Royal Society to deliver the Croonian Lecture, and at his request I made a special application to the Treasury, in accordance with which he was permitted to make a further contribution of his results, and was also most liberally allowed the use of the plates, which were prepared at Government expense for the Report. The papers from the Philosophical Transactions have since been recast, with some additions and alterations, by the author. The third part of Mr Moseley's Report, the description of the Deep-Sea Madreporaria, procured during the voyage, with most of its accompanying illustrations, appears now for the first time. I have not thought it necessary to give either lists or descriptions of reef-building Corals, or of those from shallow water. Our opportunities of collecting systematically were not nearly so great as those of many other expeditions, as, for example, the American Expedition under Captain Wilkes, where the Corals were so admirably described by Professor Dana. Much attention was, however, paid to the general structure of Coral Reefs, and any important points in connection with littoral species will be mentioned when treating of these.

Only a comparatively small number of Birds were procured by the CHALLENGER Expedition. As the object of the Expedition was almost

exclusively the investigation of the deep-sea conditions, we specially chose long courses, lying as far as possible through deep-water areas, from port to port; and when we could we chose as our long resting-places our own naval stations, or other localities frequented by Europeans, where coal and food could be got with ease.

At such places the land fauna is usually fairly well known. When we touched at out-of-the-way places, such as the Admiralty Islands or the Crozets, as many Birds were collected as possible, all the officers, naval and civilian, cordially combining to make the lists as complete as we could. The skins were carefully prepared by Pearcy, under the directions of Mr Murray, by whom the necessary notes were added. My friend Dr Sclater employed in reference to the Birds the same plan which I adopted for the general collection; he invited the assistance of the specialists most familiar with particular departments, whether special faunæ or zoological sections. The Marquis of Tweeddale completed the description of the Birds of the Philippine Islands, on which he had long been recognised as the first authority; this paper was the last of a valuable series of contributions to Ornithology, and his early death leaves a blank which will not be easily filled. Before we left England we were requested by Professor Alfred H. Garrod, F.R.S., Prosector to the Zoological Society, to make a special collection of the Procellariadæ for dissection, as he intended to work up the anatomy of the group. We attempted to carry out his wishes to the best of our power, and sent him on our return a large series in brine and spirit. We learned, however, with regret that Mr Garrod's health was in an unsatisfactory state, and he died when his task was little more than commenced. Mr William Alexander Forbes, who succeeded Mr Garrod as prosector, has undertaken to go over the collection, and to report upon it.

Dr Morrison Watson, Professor of Anatomy in Owens College, is preparing a Memoir on the Anatomy of the Penguins, a subject which, from the extreme modification of the type, offers many considerations of interest.

C. Wyville Thomson.

THE

# VOYAGE OF H.M.S. CHALLENGER.

## ZOOLOGY.

REPORT on certain HYDROID, ALCYONARIAN, and MADREPORARIAN CORALS procured during the Voyage of H.M.S. Challenger, in the Years 1873–1876. By H. N. MOSELEY, M.A., F.R.S., Fellow of Exeter College, Oxford, late Member of the Civilian Scientific Staff of the Challenger Expedition.

### GENERAL INTRODUCTION.

AT the time when the Challenger Expedition set sail, very few investigations concerning the anatomy of the soft tissues of stony corals had been made for a considerable number of years. A large number of naturalists had failed to accept as conclusive the late Professor Agassiz's results as to the hydroid nature of the MILLEPORIDÆ; the STYLASTERIDÆ were universally considered to belong to the MADREPORARIA, although Gray had formed them into a special family, and Pourtalès and Verrill had recognised some of the remarkable peculiarities of these corals. The presence of "tabulæ" in *Heliopora* had led to the association of that form with *Millepora*, and no one suspected that it was an Alcyonarian allied to *Corallium*, *Tubipora*, and *Alcyonium*.

When I undertook the investigation of the deep-sea MADREPORARIA dredged during the voyage, I naturally became anxious to examine the structure of *Millepora*, and early in the expedition attempted to make out the anatomy of *Millepora alcicornis* at Bermuda, but without much success, the problem proving too difficult. I did not succeed with *Millepora* until near the end of the voyage. The discovery which I made at the Philippine Islands, that *Heliopora* is an Alcyonarian, led me to examine the structure of all corals which were not most evidently Madreporarian, and hence I studied *Stylaster*,

and my suspicions that it belonged to the HYDROIDS were confirmed by the examination of the remarkably rich haul of STYLASTERIDÆ obtained on the homeward voyage off the mouth of the Rio de la Plata.

In the Hydroid corals of HYDROCORALLINÆ the hard skeleton appears to be developed from the ectoderm, whereas in the Anthozoan corals, both Alcyonarian and Madreporarian, it is not so produced. It seems necessary, therefore, that the term "corallum" should not be applied to the hard skeletons of both forms alike, since the skeletons in the Hydroid and Madreporarian corals can scarcely be considered homologous. I have, therefore, applied the term "cœnosteum" to the hard skeleton of the Hydrocorallinæ, retaining the old term "corallum" for that of the Anthozoan corals, whether Alcyonarian or Madreporarian.

The present memoir is divided into three parts. The first part treats of the HYDROCORALLINÆ, giving an account of the structure of the MILLEPORIDÆ and STYLASTERIDÆ, and a list of all known species of STYLASTERIDÆ, together with descriptions of the species obtained by H.M.S. Challenger. The second part describes the anatomy of *Heliopora cærulea* and of a species of *Sarcophyton*, and contains a discussion on the fossil corals which were probably allied to *Heliopora*. The third part deals with the MADREPORARIA dredged in the deep sea. It comprises a list of all the species dredged, with descriptions of new forms, and some account of the anatomy of the soft tissues of certain species, and a table showing the depths to which all known genera of deep-sea corals are as yet known to range. The literature relating to the matter treated of is shortly discussed in each part separately.

# TABLE OF CONTENTS.

## PART I.—ON THE HYDROCORALLINÆ.


PAGE

Introduction, . . . . . 11

Explanation of terms employed, . . . . . 12

### Section I.—On the Structure of the Milleporidæ.

Introduction—Mode of occurrence of *Millepora nodosa*; its appearance when living, . . . 13

Literature of the subject, . . . . . 14

Methods employed, . . . . . 17

Structure of the hard and soft parts, . . . . . 18

Main structure of the cœnosteum, . . . . . 18

Histology of the cœnosteum, . . . . . 20

Chemical composition of the cœnosteum, . . . . . 20

Structure of the zooids, . . . . . 21

„ „ cœnosarc, . . . . . 24

„ „ nematocysts, . . . . . 27

General remarks on the structure of the Milleporidæ, . . . . . 28

Vegetable parasites of the Milleporidæ, . . . . . 30

### Section II.—On the Structure of the Stylasteridæ.

Introduction, . . . . . 31

Literature of the subject, . . . . . 32

Methods employed, . . . . . 35

Structure of the hard and soft parts in the several genera of the Stylasteridæ, . . . 35

PAGE

Genus *Sporadopora*, . . . . . 36
*Sporadopora dichotoma*, structure of the cœnosteum, . . . . . 36
„ „ soft structures; cœnosarc, . . . . . 38
„ „ nematocysts, . . . . . 41
„ „ dactylozooids, . . . . . 42
„ „ zooids, . . . . . 42
„ „ gastrozooids, . . . . . 44
„ „ gonophores, . . . . . 46
Genus *Pliobothrus*, . . . . . 47
*Pliobothrus symmetricus*, cœnosteum, . . . . . 48
„ „ structure of soft parts, . . . . . 48
„ „ cœnosarc, zooids, . . . . . 49
„ „ gonophores, . . . . . 49
Genus *Errina*, . . . . . 50
*Errina labiata*, cœnosteum, . . . . . 50
„ „ soft structures, cœnosarc, . . . . . 52
„ „ zooids, dactylozooids, gastrozooids, . . . . . 53
„ „ gonophores, . . . . . 53
Genus *Spinipora*, . . . . . 55
*Spinipora echinata*, cœnosteum, . . . . . 55
„ „ soft structures, cœnosarc, . . . . . 56
„ „ zooids, . . . . . 56
Genus *Stylaster*, . . . . . 57
*Stylaster densicaulis*, cœnosteum, . . . . . 57
„ „ soft structures, cœnosarc, . . . . . 60
„ „ zooids, . . . . . 61
„ „ gonophores, . . . . . 62
Genus *Allopora*, . . . . . 62
*Allopora profunda*, cœnosteum, . . . . . 62
„ „ soft structures, cœnosarc, . . . . . 63
„ „ zooids, . . . . . 64
„ „ gonophores, . . . . . 65
Genus *Astylus*, . . . . . 65
*Astylus subviridis*, cœnosteum, . . . . . 65
„ „ soft structures, cœnosarc, . . . . . 68
„ „ zooids, . . . . . 69
„ „ gonophores, . . . . . 69

PAGE

Genus *Cryptohelia*, . . . . . 71

*Cryptohelia pudica*, cœnosteum, . . . . . 71

„ „ soft structures, cœnosarc, . . . . . 73

„ „ zooids. . . . . 73

„ „ gonophores, . . . . . 73

„ „ growth by budding, . . . . . 76

General remarks on the structure of the Stylasteridæ, . . . . . 76

Parasites of the Stylasteridæ—Pycnogonids, . . . . . 78

Distribution in space and time of the Stylasteridæ, . . . . . 78

List of the species of Stylasteridæ dredged by H.M.S. Challenger, with descriptions of new species obtained and hitherto undescribed, . . . . . 80

Description of *Distichopora irregularis*, . . . . . 80

„ „ *Stenohelia profunda*, . . . . . 82

„ „ *Conopora tenuis*, . . . . . 82

Note on *Cryptohelia pudica*, . . . . . 82

List of all the species of Stylasteridæ at present known, with localities and references, . . 83

## Section III.—General Remarks on the Hydrocorallinæ.

Classification of the Hydrocorallinæ, . . . . . 89

Tabular synopsis of the characters of the sub-order Hydrocorallinæ, its families and genera, . . 91

Characters of the sub-order Hydrocorallinæ, . . . . . 92

„ „ family Milleporidæ, . . . . . 92

„ „ „ Stylasteridæ, . . . . . 93

„ „ genus *Sporadopora*, . . . . . 93

„ „ „ *Pliobothrus*, . . . . . 94

„ „ „ *Errina* . . . . . 94

„ „ „ *Distichopora*, . . . . . 95

„ „ „ *Labiopora*, . . . . . 95

„ „ „ *Spinipora* . . . . . 96

„ „ „ *Allopora*, . . . . . 96

„ „ „ *Stylaster*, . . . . . 97

„ „ „ *Stenohelia*, . . . . . 97

„ „ „ *Conopora*, . . . . . 97

„ „ „ *Astylus*, . . . . . 97

„ „ „ *Cryptohelia*, . . . . . 98

Pedigree of the Hydrocorallinæ, . . . . . 98

# PART II.—ON HELIOPORIDÆ AND THEIR ALLIES.

PAGE

Introduction, . . . . . 102

Methods employed, . . . . . 103

Observations on *Heliopora cærulea* in the living condition, . . . . . 103

Structure of the corallum of *Heliopora cærulea*, . . . . . 103

Mode of the growth of the corallum, . . . . . 106

Mode of deposition of the hard tissue, . . . . . 107

Blue coloration of the corallum, . . . . . 109

Structure of the soft tissues of *Heliopora*; ectoderm, . . . . . 110

Endoderm; soft tissues of tubes and calicles, . . . . . 111

Canal systems, . . . . . 112

Nematocysts, . . . . . 113

Structure of the polyps, . . . . . 113

Tentacles, . . . . . 114

Stomach; mesenteries and muscles, . . . . . 115

Generative organs, . . . . . 116

Disposition of the dorsal and ventral aspects of the polyps, . . . . . 117

Structure of a species of *Sarcophyton*, . . . . . 117

Terms employed—zooids, . . . . . 118

autozooids, . . . . . 118

siphonozooids, . . . . . 119

sarcosome, . . . . . 119

vascular system, . . . . . 120

Disposition of the dorsal and ventral aspects of the zooids, . . . . . 121

General remarks, . . . . . 121

Affinities of *Heliopora*, . . . . . 121

Characters of the family HELIOPORIDÆ, . . . . . 123

Tubular cœnenchym of *Heliopora* and its homologues, . . . . . 123

Fossil allies of the HELIOPORIDÆ, . . . . . 123

Alliance of *Syringopora* and *Tubipora*, . . . . . 124

On the septa of *Heliopora*, . . . . . 125

Zooids of *Sarcophyton* and Pennatulids compared, . . . . . 125

Development of Alcyonarians and Zoantharians compared, . . . . . 126

# PART III.—ON DEEP-SEA MADREPORARIA.

PAGE

Preface, . . . . . 127

List of Monographs and Papers in which the Madreporaria occurring in the deep sea are described, . 128

Introductory remarks, . . . . . 129

Table of the depths at which all genera of Corals hitherto found in 50 fathoms and greater depths occur, . . . . . 132

List of all the Species of Madreporaria dredged by H.M.S. Challenger in deep water, and of a few shallow water forms, together with descriptions of species, and some account of the anatomy of certain species, . . . . . 134

Family Turbinolidæ, . . . . . 134

Genus *Caryophyllia*, . . . . . 134

*Caryophyllia berteriana*, . . . . . 134

„ *lævicostata*, . . . . . 134

„ *clavus*, . . . . . 134

„ *clavus, var. transversalis*, . . . . . 134

„ *communis*, . . . . . 135

„ *cylindracea*, . . . . . 138

„ *paucipalata*, . . . . . 138

„ *profunda*, . . . . . 138

„ *maculata*, . . . . . 139

„ *lamellifera*, . . . . . 140

„ *rugosa*, . . . . . 141

Genus *Acanthocyathus*, . . . . . 143

*Acanthocyathus dentatus*, . . . . . 143

„ *spinicarens*, . . . . . 143

Genus *Paracyathus*, . . . . . 144

*Paracyathus de filippii*, . . . . . 144

Genus *Heterocyathus*, . . . . . 144

*Heterocyathus philippinensis*, . . . . . 144

Genus *Deltocyathus*, . . . . . 145

*Deltocyathus italicus*, . . . . . 145

„ *magnificus*, . . . . . 147

Genus *Odontocyathus*, . . . . . 148

*Odontocyathus coronatus*, . . . . . 148

Detailed description of the corallum of *Odontocyathus coronatus*, . . . . 149

PAGE

Genus *Stephanotrochus*, . . . . . 151
*Stephanotrochus diadema*, . . . . . 152
„ *discoides*, . . . . . 153
„ *platypus*, . . . . . 154
„ *nobilis*, . . . . . 155
Genus *Cyathoceras*, . . . . . 156
*Cyathoceras cornu*, . . . . . 156
„ *rubescens*, . . . . . 157
Genus *Sphenotrochus*, . . . . . 157
*Sphenotrochus rubescens*, . . . . . 157
Genus *Pleurocyathus*, . . . . . 159
*Pleurocyathus brunneus*, . . . . . 159
Genus *Desmophyllum*, . . . . . 160
*Desmophyllum ingens*, . . . . . 160
„ *eburneum*, . . . . . 162
„ *cailleti*, . . . . . 162
Genus *Flabellum*, . . . . . 162
Notes on the structure of the soft parts of species of the genus *Flabellum*, . . . . 162
*Flabellum angulare*, . . . . . 164
„ *conuis*, . . . . . 165
„ *patagonichum*, . . . . . 166
„ *apertum*, . . . . . 167
„ *japonicum*, . . . . . 168
„ *alabastrum*, . . . . . 169
„ *patens*, . . . . . 172
„ *stokesi*, . . . . . 172
„ *australe*, . . . . . 173
„ *transversale*, . . . . . 174
„ *curvatum*, . . . . . 174
Genus *Rhizotrochus*, . . . . . 175
*Rhizotrochus fragilis*, . . . . . 175
Family Oculinidæ, . . . . . 175
Genus *Cyathohelia*, . . . . . 175
*Cyathohelia axillaris*, . . . . . 175
Genus *Neohelia*, . . . . . 176
*Neohelia porcellana*, . . . . . 176
Genus *Bathelia*, . . . . . 177
*Bathelia candida*, . . . . . 177

PAGE

Genus *Lophohelia*, . . . . . 178
*Lophohelia prolifera*, . . . . . 178
„ *candida*, . . . . . 179
„ *arbuscula*, . . . . . 180
„ *tenuis*, . . . . . 180
Genus *Solenosmilia*, . . . . . 181
*Solenosmilia variabilis*, . . . . . 181
Family Stylophoridæ, . . . . . 182
Genus *Madracis*, . . . . . 182
*Madracis asperula*, . . . . . 182
Genus *Axohelia*, . . . . . 182
*Axohelia dumetosa*, . . . . . 182
Family Astræidæ, . . . . . 182
Genus *Sphenophyllia*, . . . . . 182
*Sphenophyllia flabellum* . . . . . 182
Genus *Tridacophyllia*, . . . . . 183
*Tridacophyllia cervicornis*, . . . . . 183
Genus *Astræa*, . . . . . 184
*Astræa abyssorum*, . . . . . 184
Genus *Cladocora*, . . . . . 184
*Cladocora arbuscula*, . . . . . 184
„ *debilis*, . . . . . 184
„ *conferta*, . . . . . 185
Family Fungidæ, . . . . . 185
Genus *Bathyactis*, . . . . . 185
*Bathyactis symmetrica*, . . . . . 186
Note on the structure of the soft tissues in *Bathyactis symmetrica*, . . . . . 189
Genus *Cycloseris*, . . . . . 190
*Cycloseris tenuis*, . . . . . 190
Family Eupsammidæ, . . . . . 190
Genus *Balanophyllia*, . . . . . 190
*Balanophyllia bairdiana*, . . . . . 190
„ *malaccensis*, . . . . . 192
„ *cornu*, . . . . . 192
„ sp. (?), . . . . . 193
„ *rediviva*, . . . . . 193
„ *parvula*, . . . . . 194

PAGE

Genus *Thecopsammia* . . . . . 195
*Thecopsammia gemma* . . . . . 195
„ *elongata*, . . . . . 196
Genus *Heteropsammia*, . . . . . 196
*Heteropsammia michelini*, . . . . . 196
„ *multilobata*, . . . . . 196
Genus *Dendrophyllia*, . . . . . 198
*Dendrophyllia cornigera*, . . . . . 198
Genus *Stephanophyllia*, . . . . . 198
*Stephanophyllia complicata*, . . . . . 198
„ *formosissima*, . . . . . 201
Notes on the structure of the soft tissues of *Stephanophyllia formosissima*, . . . . 203
Genus *Leptopenus*, . . . . . 204
*Leptopenus, discus*, . . . . . 205
„ *hypocœlus*, . . . . . 208

## EXPLANATION OF THE PLATES.

HYDROCORALLINÆ—I. to XIV., . . . . . 209–230
HELIOPORIDÆ—I., II., . . . . . 231–237
MADREPORARIA—I. to XVI., . . . . . 238–248

# PART I.—ON THE HYDROCORALLINÆ.

## INTRODUCTION.

This Part of the Report contains an account of the structure of *Millepora nodosa*, and a Monograph on the structure of the Stylasteridæ, together with a list of the species dredged by H.M.S. Challenger, and a further list of all species hitherto described. It is divided into three Sections, as follows:—

Section I.—On the Structure of the Milleporidæ.
Section II.—On the Structure of the Stylasteridæ.
Section III.—General Remarks on the Hydrocorallinæ.

It is mainly a reproduction of two papers on the structure of Hydroid Corals which were, by the permission of the Lords Commissioners of the Treasury, published as parts of a Preliminary Report on the results of the Challenger Expedition in the Philosophical Transactions of the Royal Society for 1877 and 1878.[1] Certain alterations have, however, been made in the account of the structure of *Millepora*, which were necessitated by the discovery, subsequent to the appearance of that paper, of the Hydroid nature of the Stylasteridæ. The terms made use of have been altered where necessary in order to render them uniform throughout, and the whole has been revised and to a considerable extent rearranged. The list of Stylasteridæ dredged by H.M.S. Challenger, with descriptions of a few new species, is a new addition. The zoological relations of the Milleporidæ and of the Stylasteridæ are discussed separately at the ends of the parts of the treatise relating to each of them, and a general discussion on the relations of the Hydrocorallinæ as a whole, and on their pedigree, concludes the Monograph.

[1] On the Structure of a Species of *Millepora* occurring at Tahiti, Society Islands (Philosophical Transactions of the Royal Society, 1877, p. 117); The Croonian Lecture, On the Structure of the Stylasteridæ, a family of Hydroid Stony Corals (*ibid.*, 1878, p. 425).

## TERMS MADE USE OF IN THE DESCRIPTION OF THE STRUCTURE OF THE HYDROCORALLINÆ.

All the HYDROCORALLINÆ are compound structures, and consist of numerous polyps of various forms and of a common mass of hard and soft tissue by which these are supported. This common support constitutes what according to Allman's nomenclature must be termed the *hydrophyton*, or "common basis by which the several zooids of the colony are kept in union with one another." The *hydrophyton* in the HYDROCORALLINÆ consists of a hard calcareous mass which is penetrated throughout by a network of soft tissue contained within a corresponding network of canals excavated in its substance. The hard tissue is here termed *cœnosteum*, to distinguish it from the Anthozoan *corallum*, whilst the soft tissue, which together with it constitutes the *hydrophyton*, is termed *cœnosarc*. In all HYDROCORALLINÆ two forms of zooids are present; one form has a mouth and gastric cavity, the other is devoid of these and has a purely tentacular function.

For the former the term *gastrozooid* is here adopted, and for the latter that of *dactylozooid*.

The pore in the corallum occupied by the gastrozooid is termed *gastropore*, and that of the dactylozooid *dactylopore*. In the more highly differentiated STYLASTERIDÆ the pores are arranged in regular circular systems, simulating the calicular systems of Anthozoans in appearance. These systems are termed *cyclo-systems*.

## SECTION I.—ON THE STRUCTURE OF THE MILLEPORIDÆ.

### Introduction.

In a paper treating mainly of the structure of *Heliopora cærulea* which was communicated to the Royal Society in the autumn of 1875,[1] I gave a short account of the result at which I had arrived from the examination of two species of *Millepora*, obtained at Bermuda and at the Philippines, and expressed my intention of further prosecuting the subject at the Sandwich Islands and Tahiti, should material be forthcoming.

At Honolulu no *Millepora* was met with; and this form apparently does not occur at the Sandwich Islands, the water being too cold for it. At Tahiti a *Millepora* is very abundant on the reefs, in from 1 to 2 feet of water, and is very conspicuous because of its bright yellow colour.

I failed in an attempt to procure the animals of this species in an expanded condition; but my colleague, Mr J. Murray, succeeded on two occasions, and on the second occasion showed me the expanded zooids, and handed the living specimens over to me for examination. I am greatly indebted to Mr Murray for having thus afforded me the opportunity of studying the zooids of *Millepora* in the expanded condition, and I do not think that I should ever have succeeded in arriving at a satisfactory knowledge of their structure without this aid. Mr Murray further, who had had better opportunities of observing the living coral than I, first drew my attention to the fact that the central zooid of each system had a mouth. No species of *Millepora* appears hitherto to have been known to occur on the reefs of the Society Islands. In Dana's work on Corals[2] no *Millepora* is mentioned as occurring at Tahiti, and this locality is not given for any species of *Millepora* by MM. Milne-Edwards and Haime. The Tahitian species, of which the structure is here described, was determined for me by my friend, the late Dr F. Brüggemann, who, at the time of his death, was engaged in arranging and determining the collection of corals in the British Museum, to be *Millepora nodosa* of Esper.[3] The species is mentioned by M. Milne-Edwards under *Millepora gonagra*;[4] it resembles closely in form *Millepora tuberculosa* (*Millepora gonagra*), figured by MM. Milne-Edwards and Haime.[5] Like this species, it never forms foliaceous expansions, but is tuberculate and irregular in shape, and often encrusting, commonly overgrowing the dead fronds of *Lophoseris cactus*, which is a principal component of the Tahitian reefs. The present species seems, however, to differ from *Millepora tuberculosa* in that its pores are disposed over

[1] Phil. Trans. Roy. Soc., vol. clxvi., 1876, part 1, p. 91.
[2] United States' Expl. Exped., vol. vii., Zoophytes, by J. D. Dana, Philad., 1846.
[3] Esper, Pflanzenthiere, vol. i. p. 199, Millep., pl. i. (1791).
[4] Hist. Nat. des Cor., vol. iii. p. 230.
[5] *Ibid.*, pl. xiii. figs. 1*a*, 1*b*.

the surface of the cœnosteum in well-marked and separated systems, and in this respect is more closely allied to *Millepora plicata*, *Millepora foliata*, and *Millepora ehrenbergi*, as described by MM. Milne-Edwards and Haime.

In the fresh condition the growing tips of the lobes of the coral are of a bright gamboge-yellow colour, which shades off into a yellowish-brown on the sides and bases of the lobes. The expanded zooids have the appearance of a close-set pearly white down upon the surface of the cœnosteum.

The zooids seem to be somewhat capricious in the matter of expansion. I made one attempt to obtain them expanded, in which I carefully cut off masses of the coral by means of a chisel and transferred these to a glass vessel without lifting them above the surface of the water. The zooids did not expand. Mr Murray succeeded on both occasions on which he collected specimens, although he exposed his to the air for a moment on transferring them to a vessel. Dana, Pourtales, and others speak of the peculiar difficulties attending the observation of the animals of *Millepora*. The cœnosteum is so hard that it is almost impossible to break off a small flake without damaging the soft structures to such an extent that the animals fail to expand. The animals, as expanded on larger masses of the cœnosteum, can only be examined with very low powers of the microscope, which, on account of the very small size of the animals, are unable to show sufficient details in their structure. A momentary view of one dactylozooid was, however, obtained under Hartnack's objective No. 4, eyepiece No. 3. I obtained the view of the expanded zooids only on the morning on which H.M.S. Challenger was steaming out of Papiete Harbour. The animals remained expanded about two hours, but the motion of the ship interfered considerably with the investigation of them.

## Literature of the Subject.

M. Milne-Edwards (Hist. Nat. des Coralliaires, Paris, 1860, tom. iii. p. 224) formed the family Milleporidæ to include a series of genera, amongst which *Millepora* and *Heliopora* are the only recent ones, whilst he classed the Pocilloporinæ as a sub-family of the Favositidæ, together with the Milleporidæ and Seriatoporidæ, under his section of the Madreporaria Tabulata. The section was characterised by him as having the corallum composed essentially of a much developed mural system, with the visceral chambers divided into a series of stories by complete diaphragms or transverse floors, the septal arrangements being rudimentary or represented by trabeculæ, which have a greater or less extension in the intertabulate spaces. In his description of the Milleporidæ (*l. c.*) M. Milne-Edwards referred to Professor Agassiz's then recent paper, entitled "Les Animaux des Millépores sont des Acalèphes Hydroides et non des Polypes" (Bibl. Univ. de Genève, Arch. des Sci., Mai 1859, tom. v. p. 80), to the following effect:—"At the moment of

sending this chapter (on the Madreporaria Tabulata) to the press, we learn that Professor Agassiz has studied the mode of the organisation of the soft parts of the Milleporidæ, and has proved that these Zoophytes are not corals, but Hydroid Acalephs very nearly related to the Hydractiniæ. Professor Dana shares the opinion of Professor Agassiz; and Agassiz believes that the Favositidæ, as well as all other species of which the septa are not continued vertically, ought to be considered strangers to the class of corals. But the facts on which he grounds his opinion are not as yet sufficiently ascertained for us to be able to form a critical opinion of their value; and, until more ample information is received, we shall continue to rank the polyps in question according to the method adopted in our former works."

Professor L. Agassiz, in his Contributions to the Natural History of the United States,[1] figured the animals of *Millepora*. He placed *Millepora*, *Heliopora*, *Seriatopora*, *Pocillopora*, and the whole of the Tabulate and Rugose Corals with the Hydroid Acalephæ. The principal distinction between these sections and true polyps relied on by Agassiz, was as follows[2]:—"The pits into which the animals (*i.e.*, of the Milleporidæ and their supposed allies) retreat have a horizontal floor extending from wall to wall, and these floors are built successively one above another as the animal rises, the radiating portion never extending vertically through successive floors. Not so with the Actinoid Polyps, in which the radiating partitions extend from the top to the bottom of the pit, while the horizontal floors, if they exist, extend only from one radiating partition to another." Agassiz hoped that deep-sea dredgings would produce additional evidence concerning the affinities of *Millepora*, and genera connecting more closely the Rugosa and Tabulata with one another, and with the Acalephæ, in the shape of branching Heliopores and the like. (A letter concerning deep-sea dredgings addressed to Professor Benjamin Pierce, Superintendent of the United States' Coast Survey, by Louis Agassiz, Cambridge, Mass., Dec. 1871.) He had "not the remotest doubt that the Tabulata were genuine Hydroids."[3] From the time when Agassiz's observations on *Millepora* were published until the completion of the present paper, no one made any examination of the structure of the soft parts of any of the members of the Tabulata, with the exception of Professor Verrill who examined a *Pocillopora*, and found it to be a true Zoantharian polyp with twelve septa and twelve tentacles (Ann. and Mag. Nat. Hist., 1872, vol. ix., 4th series, p. 355, from Silliman's American Journal, 1872, vol. iii. pp. 187–194, On the Affinities of Palæozoic Tabulate Corals with Existing Species). Quoy and Gaimard had, however, long before described the twelve short tentacles of *Pocillopora damicornis*.

Professor Verrill, in the paper above quoted, as he had done before, combated the conclusions of Professor Agassiz that the whole of the Tabulata belonged to the Hydroid

[1] Louis Agassiz's Contribution to the Natural History of the United States of America, vol. iii. pl. xv.
[2] *Ibid.*, p. 61.
[3] *Ibid.*, p. 121.

polyps. This fact, he said, has only been proved for the Millepores: the remaining Tabulata should be joined with the true polyps, with which their relations are very near and intimate. The transverse partition-walls, the presence of which was held by Milne-Edwards and Haime as a characteristic distinction, are structures of a very low order of classificatory importance, which occur in widely different forms, and are only brought about by the simultaneous emptying of the generative products from the radial chambers. Where the emptying is not thus periodically simultaneous, a separate transverse septum is formed in each of the chambers shutting off the space thus become vacant. True tabulæ, as he showed, are found not only in *Millepora* and *Pocillopora*, but in *Cœlastræa*, *Alveopora*, and *Asteropsammia*. *Columnaria* he considered to be closely allied to *Cœlastræa*, *Favosites* to *Alveopora*, *Porites*, &c. *Heliopora* being now shown to be an Alcyonarian, tabulæ are proved to be present in forms still more widely different than is shown to be the case by Professor Verrill. The relations of *Favosites* and *Columnaria* appear now in a different light.

The opinions expressed concerning Professor Agassiz's relegation of the Tabulate and Rugose Corals to the Hydroids have been various.

Professor Allman, in his Monograph of the Gymnoblastic or Tubularian Hydroids (London, published for the Ray Society by Robert Hardwicke, 192 Piccadilly, 1871, page 3), referred to Professor Agassiz's opinion on the subject as published in his Contributions to the Natural History of the United States. He considered that since we are entirely ignorant of the generative system of the Milleporidæ, it was much safer to wait for such verification as might be expected from further researches. He hesitated to include amongst the Hydrozoal orders the Tabulate and Rugose corals.

Count Pourtalès (Illustrated Catalogue of the Museum of Comparative Anatomy at Harvard College, Cambridge, Mass., No. 4, Deep Sea Corals, p. 56) placed the Milleporidæ with the Hydroids. He remarked, "No observations have been made on *Millepora* since Professor Agassiz's first announcement of the affinities of the Millepores with the Hydroid polyps twenty years ago. The polyps of *Millepora* are very difficult to observe, both because of their small size, and because they are killed by the shortest contact with air; when obtained expanded, they contract on the slightest shake of the vessel containing them. I have succeeded but once, in company with Professor Agassiz, in having a good view of one of the larger polyps of *Millepora alcicornis*. It differed from the figure in the Contributions to the Natural History of the United States, vol. iii. pl. xv. fig. 1, in being comparatively shorter and having larger tentacles, or rather tentacular masses studded with lasso cells five in number instead of four. The mouth was not seen very distinctly, but appeared to be a transverse slit in the middle of the disc. It remained expanded but a short time." Pourtalès rightly placed his genus *Pliobothrus* amongst the Hydroids; but, judging from the structure of the hard parts alone, associated it with *Millepora*.

Professor Claus' Grundzüge der Zoologie, 3te Auflage, 1874, p. 226, rightly placed the Milleporidæ with the Hydroids.

General Nelson's figures (published by Professor Martin Duncan[1]) of the animals of *Millepora alcicornis* do not seem to be of very much value. They appear to represent imperfect conceptions of the dactylozooids. In September 1878 Mr William North Rice published a short account of his observations of the living polyps of *Millepora alcicornis* at Bermuda. He saw apparently only the dactylozooids, of which he gives outline figures. The tentacles are not disposed in them in whorls of four as figured by General Nelson, but more as in *Millepora nodosa* as described by me. His results go to confirm my own in several points of importance.[2]

## Methods Employed.

Sections of the corallum were prepared in the usual manner by grinding. Portions of the living coral were placed in various solutions for subsequent examination, viz., in absolute alcohol, chromic acid, and glycerine. Portions were further treated with osmic acid, and then transferred to glycerine or absolute alcohol. Fragments of the hardened coral were subsequently decalcified with hydrochloric acid, and the residual soft structures were either mounted entire for examination, or cut in the usual manner into fine vertical and horizontal sections. The sections were stained with carmine or magenta. The specimens hardened in osmic acid, and decalcified after subsequent immersion in absolute alcohol, yielded the best histological results. Those which had been hardened in absolute alcohol alone gave the best results as to the coarser anatomy. The specimens preserved directly in glycerine preserved most perfectly the forms of the several histological elements, and especially yielded good preparations of the thread-cells, preparations of which are best procured by grinding up between two glass slides a zooid and its immediately surrounding calcareous bed, removed with the point of a scalpel. A view of the structure unacted upon by acids is thus obtained. The specimens placed in chromic acid were of little service for sections, owing to a thick crystalline deposit of sulphate of lime which formed upon them in the solution; but they showed best, on the under surface of the decalcified superficial film, the ramifications of the soft parts of the hydrophyton. Dr G. von Koch's[3] method of cutting sections of corals in which both the hard and soft parts are displayed in the same preparation will no doubt yield excellent results in the case of the Hydrocorallinæ.

[1] Ann. and Mag. Nat. Hist., vol. xvii. p. 354.

[2] Wm. North Rice On the Animal of *Millepora alcicornis*, American Journ. of Science and Art, vol. xvi., Sept. 1878, p. 180.

[3] For an account of the method, see Zool. Anzeiger, Bd. i.

## Structure of the Hard and Soft Parts.

### Cœnosteum of *Millepora*.

The structure of the cœnosteum is illustrated on Plate XIII. The cœnosteum has a widely spread encrusting base covering rocks, dead corals, &c., and at its surface presents a series of projecting, short, irregular tubercles and lobules, which never rise to any considerable height. Fig. 3 represents the appearance of two lobules of the cœnosteum and a portion of a third, enlarged two diameters. The surface of the lobules is uneven and covered with slight rounded elevations. The pores of the zooids are dispersed over the entire surface both of the lobules and of the flatter encrusting portions of the cœnosteum, being absent only at the tips of some of the lobules, which are possibly those that are in rapid growth. The pores are disposed in irregularly circular groups, a larger gastropore being in the centre of each group or system with usually from five to eight smaller dactylopores arranged around it. These systems of pores often occupy small rounded prominences on the surface of the cœnosteum, and in parts of some specimens almost every system appears to have its separate small prominence. In some regions of the cœnosteum the systems are scarcely defined, the calicles appearing irregularly placed; but such an arrangement is only exceptional in the present species. An entire system of calicles has been accurately drawn for me by Mr J. J. Wild and is represented in Plate XIII. fig. 4, enlarged eighty diameters. The outlines of the pores are seen to be extremely irregular; their cavities are encroached upon in all directions by projections of the contorted trabecular cœnenchymal tissue of the cœnosteum. The larger central gastropores of the systems measure about 1·5 mm. in diameter.

The main mass of the cœnosteum is composed of trabeculæ of dense calcareous matter, which forms a spongy-looking mass traversed in all directions by tortuous canals. In some species of *Millepora* the cœnosteum is much more dense than in the Tahitian one, and in these might rather be described as a compact mass in which a series of tortuous channels are excavated for the reception of the soft structures. In such species of *Millepora*, in finely-ground sections of the cœnosteum, the tortuous canals become filled with opaque debris, and show out, when the section is viewed by transmitted light, dark on a light ground. In a species of *Millepora* obtained at Samboangan the cœnosteum was of this nature. The appearance presented by a thin section of its cœnosteum is shown in Plate XIII. fig. 7. In *Millepora alcicornis* and in the Tahitian species the canal systems and trabeculæ of calcareous matter seem to form equally complex interpenetrating meshworks. The canal systems correspond to, and in the recent state contain, the ramifications of the soft parts of the cœnosarc. The canals form regular branching systems with main trunks which give off numerous branches from which arise secondary branches and from these again smaller ramifications. The whole canal-system is connected together by a freely anastomosing meshwork of smaller vessels, and communicates freely by numerous offsets

with the cavities of the pores. In Plate XIV. fig. 4, part of one of these canal-systems is shown, being there drawn from a decalcified specimen, and thus representing the soft tissues which in the recent state occupied corresponding calcareous canals. In Plate XIII. fig. 6, a secondary branch of one of the canals is seen to communicate with a pore cavity, C'. The course of the smaller vessels being tortuous, only short lengths of them are exposed in the remainder of this section. Similar secondary branches are seen in vertical section in Plate XIII. fig. 5, B, B.

Where a *Millepora* encrusts foreign bodies, the investing film of cœnosteum formed is usually extremely thin. At Bermuda, *Millepora alcicornis* is frequently found encrusting glass bottles thrown into the harbours. The film of cœnosteum can, in such specimens, easily be detached in flakes from the glass, and does not measure more than from 1-8th to 1-5th of a millimeter in thickness. In the same manner at Bermuda the dead fans of a *Gorgonia* are found entirely encrusted with a thin film of *Millepora*, so thin that the fenestrations of the horny meshwork of the *Gorgonia* are not obliterated. Such thin encrusting films, if obtained in the living condition, would, no doubt, be excellently adapted for the study of the soft parts of *Millepora*, since they are thin enough to transmit a considerable amount of light. When dead and dry they show extremely well the ramifications of the canal-systems and their connections with the pores. In such films the dactylopores and gastropores are fully developed, though necessarily very shallow; and it is evident that such a thin film of cœnosteum is all that is absolutely necessary for the existence of the *Millepora*, and, in fact, in all Milleporidæ it is such a thin film only which is actually living, covering the surface of the cœnosteum. In a *Millepora* forming tubercular or ramified masses a superposition of a series of such films takes place and constitutes the coral mass.

In the films encrusting bottles the under surface in contact with the glass is perfectly continuous and highly polished, and is exactly moulded on the surface of the glass, reproducing casts of the most minute splinterings or scratchings.

In homology with this continuous layer, layers more or less continuous occur in the more massive cœnosteum appearing in vertical sections as lines of calcareous matter running parallel to the surface of the cœnosteum and indicating successive stages of growth, and the tubercles of which the mass of the Tahitian *Millepora* is made up, when cut through vertically to the surface, show a series of such lines of growth following the contour of the surface. It is in connection with these layers that are developed the successive transverse laminæ or tabulæ which divide the cavities of the calicles into a series of chambers (Pl. XIII. fig. 5). As the cœnosteum is extended in growth at certain intervals, possibly after each period of generative activity, a tabula is formed, reducing the depth of the calicle and shutting off the living tissue from the abandoned dead structures below. The larger canals and their branches ramify in planes parallel to the surfaces of the cœnosteum, being confined within each successively added thin layer of the cœnosteum, and

never take a vertical course leading from the depths of the coral to the surface. A free vertical communication is, however, established by the smaller vessels (Pl. XIII. fig. 5). In the thin films of *Millepora alcicornis* the trabeculæ of hard tissue run with remarkable uniformity in straight lines parallel to one another, whilst the main canals cross them with a serpentine course.

*Histology of the Cœnosteum.*—In histological structure the hard tissue composing the cœnosteum of *Millepora* seems to resemble closely that of the coralla of *Heliopora* and most Anthozoa. It is composed of lamellæ of fibro-crystalline calcareous matter (Pl. XIII. fig. 8), the fibres of the superposed lamellæ crossing one another at all angles in the mass. In some places, in thin sections of the cœnosteum, the appearance shown at *a* (Pl. XIII. fig. 8) is clearly to be seen. The calcareous fibres of the hard tissue terminate towards a cavity in the cœnosteum as a series of short points, seeming to show a composition of the hard tissue out of definite rod-like elements. Such an appearance is only to be met with sparingly, and possibly occurs at spots where the cœnosteum was in active growth. The hard tissue is bored in all directions by parasitic vegetable organisms (Pl. XIII. figs. 6 and 8).

*Chemical Composition of the Cœnosteum.*—Although the animals forming the cœnosteum of *Millepora* differ so widely from those by which all other corals except the Stylasteridæ are secreted, their cœnostea appear to agree in chemical composition with those of other corals as closely as they do in histological structure. Analyses of the cœnostea of two species of *Millepora* are given by Professor Dana. One is an analysis of *Millepora tortuosa* from the Fijis, by Mr Silliman, Jun.[1] The composition was found to be as follows :—

| | |
|---|---|
| Carbonate of lime . . . . | 94·226 |
| Phosphates and fluorides . . . | 1·200 |
| Organic matter . . . . . | 4·574 |

Mr S. P. Sharples[2] found the cœnosteum of *Millepora alcicornis* to consist of—

| | |
|---|---|
| Carbonate of lime . . . . . | 97·46 |
| Phosphate of lime . . . . . | 0·27 |
| Water and organic matter . . . | 2·4 |

There is no marked difference between these results and those obtained from Anthozoan corals.

[1] Structure and Classification of Zoophytes, by J. D. Dana, A.M., Philadelphia, Lea and Blanchard, 1846, Appendix, p. 130.

[2] Corals and Coral Islands, by J. D. Dana, London, 1872, p. 105.

## Soft structures of *Millepora*.

*Structure of the Zooids.*—The pores of *Millepora* are occupied by two kinds of zooids. In each system of calicles the central larger one is occupied by a short and broad gastrozooid provided with a mouth, whilst the surrounding smaller calicles lodge longer and more slender dactylozooids which have no trace of mouth. A system of expanded zooids is shown (Pl. XIV. fig. 1), one of the dactylozooids being omitted in the drawing in order to show the central gastrozooid more clearly.

*Gastrozooids.*—The gastrozooids are much shorter and broader than the dactylozooids. They were not directly measured but were estimated to be about ·5 mm. in height. They are cylindrical in form, with a short conical hypostome, and four, five, or six tentacles arranged equidistantly in one whorl just below the hypostome. The tentacles consist of a short, stout, cylindrical stem, with a spheroidal knob-like tip composed almost entirely of nematocysts. At the summit of the hypostome is the mouth, which in the living expanded animal has a conspicuous glistening white appearance—no doubt because light is strongly reflected by the large gastric cells which surround the aperture.

The mouth-area is circular in outline (in *Millepora alcicornis* quadrangular sometimes), Pl. XIV. fig. 2, G Z. The circular area is occupied by a series of large, elongate, transparent gastric cells, which are disposed in a radiating manner around the centre of the area. The actual mouth-orifice takes the form either of a threefold or cruciform slit between the gastric cells. The gastric cells (Pl. XIV. fig. 7) are elongate, irregularly cylindrical in form, and transparent and bladder-like in appearance, and without any trace of a nucleus. They line the internal cavity of the gastrozooid for at least one-third of its length, but to what extent exactly was not ascertained. They are figured by Professor Agassiz in a figure of a gastrozooid of *Millepora alcicornis* (*l.c.* Pl. XVI. fig. 6). They appear to be closely similar to the piriform cells described by Allman, and figured by him as occurring in *Gemmaria implexa*.[1] They are here termed gastric, because the fact that they occur only in the gastrozooids seems to render it probable that they exercise a digestive function.

*Dactylozooids.*—The dactylozooids are long and slender in comparison with the gastrozooid. They differ very much in length, as will be seen from the figure; the longest of them measure about 1½ mm. in length. They are cylindrical in form, tapering towards the upper extremity. They have no trace of a mouth, nor of any of the gastric cells of the gastrozooids in their body-cavity. They bear tentacles at irregular intervals from near the bases to the summits of their bodies. The tentacles are very variable in number; some zooids have only five tentacles, whilst all numbers from five to twenty (and possibly, in exceptional cases, a slightly greater number) occur in others. From twelve to fifteen is the most usual number. The tentacles consist of a cylindrical stem, longer and more

[1] Allman, Gymnoblastic and Tubularian Hydroids, pl. viii. fig. 5.

slender than in the gastrozooids, and a spheroidal tip resembling that of the tentacle of the gastrozooid, but smaller. The body of the dactylozooid terminates sometimes in two, sometimes in three tentacles, springing from a common point.

The dactylozooids expand far more readily and quickly than the gastrozooids, of which latter it is comparatively difficult to obtain a view in the expanded condition. The short gastrozooids appear to remain perfectly quiescent when expanded, whilst the dactylozooids are in constant serpentine motion. The dactylozooids seldom carry their bodies extended straight, but usually bent in several curves; they appear to bend over towards their gastrozooid from time to time, as if to convey food. All the zooids are retracted on alarm with remarkable suddenness, disappearing entirely within the pores.

When a portion of the coral has been placed living in reagents, it is found, after becoming hardened, to be bristling all over with sheaves of threads shot from the nematocyst around the mouths of the calicles. By some accident, on one small portion of a coral placed in absolute alcohol, the dactylozooids all remained partially protruded. This was only over a small area of about $\frac{1}{4}$ of a square inch in dimensions, enough to yield a single microscopical preparation. From a very large quantity of the coral prepared in an exactly similar manner, no second preparation could be obtained, though it was all searched over carefully for similarly expanded zooids. This fact, however, shows that perhaps it might have been possible to obtain a larger quantity of expanded zooids in the hardened condition by the gradual addition of alcohol or fresh water to the sea-water in which the living animals were expanded, or by some similar means; or perhaps by the sudden addition of osmic acid solution as recommended by F. E. Schulze.[1]

The body of the zooids, when seen in transverse section, is found to consist (Pl. XIV. fig. 7) of an ectodermal layer, beneath which is a layer of membrane, and an internal mass of endodermal cells. The ectodermal layer, as studied in sections of hardened specimens, appears to consist of well-defined cells, most of which contain small nematocysts, whilst some contain simple nuclei. The membranous layer is apparently structureless; it extends throughout the body and tentacles. Beneath the membranous layer, and in close union with it, are the muscular structures to be presently described, and within these, in the case of the gastrozooids, are, in the upper region of the body, the gastric cells already described. The structure of the endoderm in the lower part of the body of the gastrozooids, and in the dactylozooids, was not well ascertained. In transverse hardened sections the body-cavity is seen to be entirely filled with the pigmented yellow cells, which also fill the canals of the cœnosarc. In the tentacles of the dactylozooids, however, of which a glance was obtained under a high power, the transverse lines or apparent septa, so characteristic of the Hydroids (Pl. XIV. fig. 5), and considered by Allman to be in reality the opposed walls of large adjacent endodermal cells, were clearly

[1] Anleitung zu wissenschaftlichen Beobachtungen auf Reisen. Herausgegeben von C. Neumayer, Hydrograph der kaiserlichen Admiralitat, Berlin, 1875, Wirbellose Seethiere von K. Mobius, p. 424.

seen, and also multiramified amœboid-looking corpuscles occurring in the endoderm (same figure, R C), and resembling those figured by Allman as occurring in the tentacles of *Coryne pusilla*, and considered by him to be the nuclei of the large endodermal cells.[1]

The body-cavities of the zooids were observed in the living condition to be filled with the yellow pigmented cells, and a few of these cells were seen occasionally to penetrate a short distance into the cavities of the tentacles, which cavities are continuous by widely open mouths with those of the bodies of the zooids. Ciliation of the somatic cavities could not be seen.

The spheroidal heads of the tentacles are composed of masses of closely-set nematocysts of various sizes and stages of development, but all of one peculiar kind (Pl. XIII. fig. 2), the larger ovoid nematocysts never occurring in them. A thin hyaline, apparently structureless ectodermal layer extends between these agglomerated nematocysts, its marginal outline not being circular but depressed in short curves between the somewhat projecting tips of the cells (Pl. XIV. fig. 5).

The gastrozooids, when retracted, viewed directly from above, show the mouth in the centre, and four, five, or six tentacles arranged at equal distances around. The dactylozooids, when retracted, have their tentacles closely drawn together, so as to form a hemispherical mass composed of the closely-set spheroidal tips of the tentacles (Pl. XIV. figs. 2 and 3). It can easily be understood how a vertical section through such a mass of retracted minute tentacles would give the appearance of a large compound tentacle, the small tentacles appearing to constitute the pinnæ. I was misled by such a preparation; and in my paper upon *Heliopora cærulea*, presented to the Royal Society,[2] I stated my belief that the tentacles of *Millepora* would prove to be compound.

The body-cavities of the zooids terminate inferiorly in blind ends at the bottoms of the calicles, but are continued outwards at their bases in all directions into the canals of the hydrophyton, which join them all around, being disposed in an irregularly radiate manner (Pl. XIV. figs. 2 and 6).

Muscular fibres, having a longitudinal disposition, are extremely well developed in the zooids. They arise for the most part in bundles from the radiating vessels of the cœnosarc, which spring from the bases of the zooids, and pass up the walls of the bodies of the zooids, extending in the gastrozooids nearly as far as the mouth. In the contracted zooids, when viewed directly from above or below, they have necessarily a radiate disposition, as shown in Plate XIV. fig. 6. Not all the fibres are gathered into the bundles, but some sparsely spread ones occupy the interval between these bundles, maintaining a like radiate course. The bundles may be traced for a considerable distance along the radiating vessels. In vertical sections from osmic acid preparations the muscular elements can be observed as isolated excessively fine fibres (as far as was seen, without nucleus), which

[1] Allman, Gymnoblastic and Tubularian Hydroids, pl. iv. fig. 3.
[2] Phil. Trans., vol. clxvi., part 1.

appear to be distinct from the membranous layer of the zooid, though in close relation with it. These bundles of longitudinal fibres are plainly to be seen in preparations of all kinds, and no doubt it is to their presence that the zooids owe their power of almost instantaneous retraction. In several osmic acid preparations an appearance indicating the existence of a set of circularly-directed fibres lying externally to the longitudinal fibres, or possibly of circular fibrillation of the membranous layer, was seen, but the existence of such structure was not determined with certainty.

*Cœnosarc.*—The canals and spaces within the calcareous cœnosteum are occupied, as has already been stated, by a network of soft tissue. This, together with the superficial layer of ectoderm, constitutes the cœnosarc. Only a thin layer at the surface of the coral is living. This layer separates from the underlying dead matter when the coral is decalcified in acids, and appears as a soft membrane about ·5 mm. in thickness. When the entire cœnosteum is dissolved away there remains besides this membrane only a greenish gelatinous mass, which consists of the mycelium and spores of the parasitic organisms, which were the sole living occupants of the deep parts of the cœnosteum. The living part of the Hydroid seems to be entirely confined, as is the case in *Heliopora cærulea*, to the region superficial to the last-formed tabulæ.

The cœnosarc consists of a series of ramifying canal-systems, which occupy in the recent condition the canals already described as existing in the cœnosteum. The branches and secondary branches of the canals are joined by a complex network of smaller vessels, which join in all directions the body-cavities of the zooids (Pl. XIV. fig. 4), and thus maintain a vascular connection of the freest character between the various zooids of the colony. In some cases, comparatively large tertiary branches of the canals join the zooid-cavities directly. The large main canals run sometimes for long distances, and in a species of *Millepora*, obtained at Samboangan, Philippines, their corresponding channels in the hard tissue are plainly visible to the naked eye on the surface of the corallum, extending sometimes for as great a distance as $1\frac{1}{2}$ inch. The ramifications of the cœnosarc are best seen on the under surface of the superficial living film decalcified in chromic acid and viewed by reflected light. The appearance presented in such a preparation is accurately represented in Plate XIV. fig. 4. The appearance of the cœnosarc, as seen in vertical section, is shown in Plate XIV. fig. 2. In the more superficial region of the living layer, the elements of the network take a direction more or less vertical to the surface. The horizontally directed main canals and their branches lie near the under surface of the layer on a level with the bases of the zooids.

The histological structure of the cœnosarc is shown in Plate XIV. fig. 8. The canals and vessels forming the network are composed of an ectodermal layer, with a membranous layer developed beneath it, and an endodermal lining.

The ectodermal layer consists, in the greater part of the network, of fusiform cells with a finely granular appearance and a well-defined oval nucleus, but with the cell-

boundary often very indistinct. The cells form in some places much thicker layers than in others. Towards the most internal part of the cœnosarc they become entirely lost, their place being taken on the surface of the thin-walled cyst-like innermost elements of the network by a thin layer of structureless protoplasm (Pl. XIV. fig. 8, B).

Narrow strings of this ectodermic protoplasm (Pl. XIV. fig. 8, S) cross over here and there between adjacent vessels of the innermost part of the network, being possibly the remnants of effete vessels. The ectoderm covering the parts of the network near the surface is much thickened and modified, a large proportion of its cellular elements being there found converted into the parent-cells of nematocysts, and being thus inflated and occupied by nematocysts in all stages of development.

At the actual surface, the ectodermal cells undergo still greater modification, forming a superficial layer of elongate prismatic transparent cells, which shows on the surface a series of irregularly hexagonal areas corresponding with the summits of the cells. These cells contain oval nuclei and nematocysts of both kinds in various stages of development. The most superficial film showing the hexagonal areas separates often in osmic acid preparations as an exceedingly thin membrane, as is shown on the right-hand side of Plate XIV. fig. 8. There is some uncertainty as to the exact structure of the superficial layer of the ectoderm. The figures represent what, after a careful investigation, was concluded to be the arrangement existing. The layer is seen well only in preparations from specimens hardened in osmic acid. The lateral boundaries of the prismatic cells were never seen well defined, but the polygonal areas, corresponding with their summits, were seen well in various preparations. It could not be demonstrated with certainty that this layer extends uniformly all over the external surface of the cœnosarc. It is extremely transparent, and difficult to trace in preparations viewed from the surface, over the cavities caused by the removal of the hard parts by decalcification.

The exact arrangement of the superficial layer in its connection with the mouths of the calicles and zooids is also somewhat uncertain. The layer certainly is prolonged into the calicular cavities, and contains the mass of large oval thread-cells which surrounds each zooid. In most preparations the zooids are far retracted through the action of reagents, and the mouths of the calicles are closed above by a layer of tissue which shows a radiate striation or slight plaiting around a very small circular central orifice, which orifice leads down a short tubular cavity formed by the superficial layer drawn everywhere inwards to the retracted zooids of the calicle. The layer of tissue thus contracted over the calicle nearly or sometimes completely closes it, and thus usually the zooid can be seen in preparations in which the cœnosarc is viewed from the surface only by focusing the objective into the depths of the tissue. The orifices of the pores of retracted zooids were unfortunately not carefully examined in the living condition of the coral; hence, it is uncertain whether the superficial tissue contracts in this manner in the living condition so as to close the orifice of the pore, and protect the zooid, or whether such extreme contraction

occurs only through the action of reagents. It seems probable that it does occur in the living animal, since by its means the masses of large thread-cells are brought as a protection directly between the zooid and the exterior. Just as in one small portion of the coral the zooids died in the expanded condition, so more often, in certain specimens, they die and are preserved with the superficial ectodermal layer not closed in over the mouth of the calicle, but with the calicle open, and their retracted tentacles remaining fully exposed to view from above. In Plate XIV. figs. 2 and 3, both zooids figured are shown in this latter condition. The connection between the superficial ectodermal layer within the calicle and the adjacent vascular network of the cœnosarc was not made out. The layer is probably merely the largely developed ectodermal layer of that part of the network, but the connection not having been seen is not indicated in Plate XIV. fig. 2.

The superficial layer of the cœnosarc being a special development of the ectodermal cells of the vascular network, and the interspaces in this network being occupied by calcareous trabeculæ, it follows either that the tips of the trabeculæ at the surface of the cœnosarc must be directly exposed, or that the superficial ectodermal cells of the network must close in over them. The latter arrangement seems to occur; and in vertical sections of the decalcified cœnosarc numerous spaces left by removed calcareous structures are seen in the superficial ectodermal layer (see Pl. XIV. figs. 2 and 8), with the ectodermal cells arching over to cover them. I should have had no doubt in this matter had I not observed that in the living *Millepora* the soft parts of the cœnosarc appear to be retracted below the surface of the cœnosteum when the zooids are in their retracted condition. It can, however, hardly be the case that any part of the cœnosteum is directly exposed to the water. It is probably always covered everywhere by the superficial layer of the ectoderm, which, however, is in the recent condition so transparent as to escape observation. The calcareous tissue of the cœnosteum must obviously be deposited by the ectoderm, with which alone it is in contact. It spreads by extension of the trabeculæ at the surface; and since there it is seen to be often in contact only with the cells of the superficial layer, it seems that these cells must have the power of producing it. The calcareous network undergoes thickening in the deeper parts of the living lamina, as must necessarily be the case, because of the formation of the tabulæ and lines of growth. In these parts no doubt the fusiform nucleated cells of the ectoderm are the instruments of the deposition of the carbonate of lime. No special calciferous tissue was observed, such as exists in *Heliopora cærulea*.

Beneath the layer of ectodermal cells in the vascular canals composing the cœnosarc lies a layer of apparently homogeneous membrane, which appears to form everywhere a wall to the vessels and canals. The cavities of the vascular network are lined by, and in many places nearly filled with, cellular elements of two kinds—pigmented cells and small transparent globules. The pigmented cells (Pl. XIV. fig. 9) closely resemble those

of other Hydroids. They are figured by Professor Agassiz[1] as occurring in *Millepora alcicornis*. They are spheroidal in form, with transparent wall, and contents composed of irregular granules, which are of a bright gamboge-yellow colour. It is these cells which give the bright yellow tinge to the tips of the living coral. The cell-contents in these cells are frequently to be seen divided into two, each half having its own nucleus, or sometimes more rarely into four (Pl. XIV. fig. 9, *b*, *c*). The more superficial part of the vascular network of the cœnosarc is in most places almost crammed full of these pigmented cells, and they are abundantly present also within the somatic cavities of the zooids. They become less abundant towards the deeper parts of the living layer, and in certain of the deepest ramifications of the network are entirely absent, their place being taken by transparent globules. In some parts of the hydrophyton large quantities of the pigmented cells are met with which are coloured dark brown instead of yellow. These belong probably to the older parts of the coral, which have in the living condition a brown appearance, it being only the growing tips which are bright yellow. Such, however, was not ascertained to be the case.

At the under surface of the living layer of the hydrophyton the cœnosarcal network has in connection with it, or is prolonged into, a network of extremely transparent thin-walled vessels, many of which terminate in blind extremities, as shown in Plate XIV. fig. 8, B. These vessels are distended with small exceedingly transparent and highly refractile globules, without any admixture of pigmented cells. These transparent globules are found scattered amongst the pigmented cells throughout the vessels of the cœnosarc, but occur in masses only as above described. No clue to the function of these transparent globules, nor explanation of their being thus agglomerated in the deeper parts of the living layer, was obtained; the masses of them probably point to a fatty degeneration of the effete deep regions of the network of the cœnosarc.

*Nematocysts.*—The nematocysts are of two kinds. They are shown, carefully drawn to measurement, in Plate XIII. figs. 1 and 2. One kind is that which appears to be confined to Hydrozoa, and not to occur at all in Anthozoa, viz., that in which a bladder-like enlargement of the thread occurs at that part of it which is immediately next the mouth of the cell, the bladder being armed near its summit by three spines set in one whorl. The three spines in this form of nematocyst in *Millepora* are remarkably long, and directed at right angles to the axis of the thread, instead of recurved, as usual. These nematocyst vary very much in size. The one figured is one of the largest observed, being of about two-thirds of the length of the ovoid nematocysts. The larger examples of these three-spined nematocysts are of comparatively rare occurrence, only a few being present in some of the tentacles, and being more commonly present in the tentacles of the gastrozooids. The smaller nematocysts of this form have not more than 1-6th of the length of the larger ones. They form the bulk of the spheroidal

[1] *Loc. cit.*, plate xv. fig. 5.

tips of the tentacles of the zooids; but both large and small nematocysts of this kind occur also in the cœnosarc.

The larger ovoidal nematocysts are also such as occur in Hydroids, but are not of so characteristic a form as the three-spined kind. They, as well as the others, were already figured by the late Professor Agassiz from *Millepora alcicornis*. These nematocyts never occur in the tentacles of the zooids, being confined to the cœnosarc, and being present in the greatest abundance in zonal masses around the bases of the zooids lying in the superficial layer of the ectoderm. Both these forms of nematocysts occur together in *Gemmaria implexa*, and with a similar distribution.. In *Millepora alcicornis*, according to Professor Agassiz,[1] these ovoid nematocysts occur in abundance in the tentacles of the zooids. Possibly he was mistaken in the matter.

Both kinds of nematocyts occur, in all stages of development, in the ectoderm of the vascular network of the cœnosarc, extending in position to a considerable depth from the external surface of the coral (Pl. XIV. fig. 8).

The nematocyst appears to be developed out of the nucleus of the ectodermal cell, the ectodermal cell becoming much enlarged and forming a wide chamber in which the process of development takes place. The ovoid nucleus becomes enlarged together with the cell, but not at all in the same proportion, the cell always appearing as a wide cavity around it. The nucleus, as it enlarges, has a rounded nucleolus developed at one end of it. The nucleolus has large granules developed within it, whilst the nucleus becomes finely granular. In the next stage one large coil of the thread appears in the nucleus. Nothing further could be made out from the hardened specimens as to the development of the nematocysts.

Most unfortunately no trace of generative organs could be detected in connection with any of the zooids, neither in the *Millepora* from Tahiti nor in the other two species examined. These other two species have essentially the same structure as the Tahitian species, having dactylozooid and gastrozooid. They have both of them closely similar nematocysts of both forms and with a similar distribution. Moreover, the larger nematocysts have very nearly the same dimensions in all three species; they are a trifle smaller only in *Millepora alcicornis*. This latter species and the Samboangan one differ from the Tahitian species mainly in not having their zooids grouped in distinct systems.

## General Remarks on the Structure of the Milleporidæ.

Although, most unfortunately, no evidence as to the structure of the generative system of *Millepora* has as yet been obtained, the results here set forth yield, nevertheless, I think, convincing proofs that this interesting form of coral is a true Hydroid, as discovered by Agassiz in 1859. The peculiar structure of the cœnosarc, the forms of the

[1] *Loc. cit.*, vol. iv. p. 293.

zooids, the absence of all trace of mesenteries, the apparent septa present in the tentacles, the presence of the nematocysts of the form peculiar to Hydrozoa, and in fact every item of histological structure, point irresistibly to the same conclusion. Professor Agassiz considered the Millepores to be allied to the Hydractiniæ, and Claus remarks on their resemblance in some points to the Corynidæ. Both *Hydractinia* and *Podocoryne* resemble *Millepora* in having a cœnosarc which forms a continuous encrusting layer; and in essential structure the cœnosarc of these two genera seems closely to resemble that of *Millepora*. Mr Carter[1] has described a species of *Hydractinia* from the Guinea coast, *H. calcarea*, which has a hard calcareous cœnosteum. The genus *Podocoryne* (Sars) has a "hydrophyton consisting of a continuous adherent expansion formed by adnate inosculating canals, the deeper part, with its component canals, invested by a chitinous perisarc, while a layer of naked cœnosarc spreads over the free surface." In *Millepora* the canals are not adnate, being separated by the stout trabeculæ of calcareous matter which here take the place of the chitinous perisarc. The layer of naked cœnosarc on the surface is probably homologous with the layer in the cœnosarc of *Millepora* described in the present paper as the superficial layer of the ectoderm. The structure of the cœnosarc of *Hydractinia* is essentially similar to that of *Podocoryne*. Distinctive features in the cœnosarc of *Millepora* are the presence in it of the pore-like excavations into which the zooids are retracted, the presence of large main branching canals, and the formation of successive superposed layers of cœnosarc, and consequent formation of lines of growth and tabulæ in the calcareous skeleton. In having zooids of two kinds, mouth-bearing and mouthless, the Millepores resemble *Hydractinia echinata*, which bears likewise alimentary (gastrozooids) and spiral mouthless zooids (dactylozooids). In the form of the zooids, however, and shape and arrangement of the tentacles, and in the nature of the nematocysts,[2] *Millepora* seems to resemble such a form as *Gemmaria implexa*. The real affinities of *Millepora* amongst the Hydroids cannot, however, be determined until the mode of reproduction is discovered.

It is a remarkable fact that the cœnosteum of *Millepora* seems undoubtedly to be generated by the ectoderm. It is thus not homogenous with the corallum of Anthozoa, which is developed from the mesoderm, as appears certain in the latest accounts of the matter from M. Lacaze-Duthiers'[3] researches on *Astroïdes calycularis*, and from those of Kowalewsky[4] on *Astræa* and on *Alcyonium digitatum*. I have, for this reason,

[1] H. J. Carter, F.R.S., On the Close relationship of *Hydractinia Parkeria* and *Stromatopora*, with Descriptions of new species of the former, both recent and fossil, Ann. and Mag. Nat. Hist., vol. xix. p. 44, 4 ser., 1877.

[2] It would seem that a classification and nomenclature of the various forms of thread-cells is much needed, since these forms appear to be of classificatory value in the Cœlenterata. Certain forms are peculiar to Hydroids, *e.g.*, others to Alcyonaria.

[3] H. de Lacaze-Duthiers, Développement des polypes et de leur polypier, Comptes Rendus, 1873, t. lxxvii. (Hoffman und Schwalbe, Jahresbericht, 1875).

[4] A. Kowalewsky, Untersuchungen über die Entwicklung der Cœlenteraten, Nachrichten der kaiserlichen Gesellschaft der Freunde der Naturerkenntniss, der Anthropologie und Ethnographie, Moskau, 1873. (*Ibid.*)

as already explained, adopted a distinctive term for the calcareous skeleton of the Hydrocorallinæ. In *Alcyonium* two elements are recognised by Kowalewsky as composing in the embryo the "intermediate layer" (mesoderm), viz., a homogeneous membrana propria, which lies internally and penetrates the mesenterial folds, and a peculiar thin layer of cells, which lies externally to this membrana propria. It is from this thin layer of cells that the gelatinous connective tissue, the spicules, and canal networks are formed. This special layer does not exist in other corals nor in *Cerianthus*.

The close resemblance in the histological structure of the calcareous skeleton formed by animals so different as Alcyonaria (*Heliopora cærulea*), Zoantharia, and Hydroida is a remarkable fact. The whole of the Milleporidæ at present known appear to be naturally referable to the one genus *Millepora*, unless *Porosphæra* (Steinm.), a Cretaceous fossil is, as suggested by Alleyne Nicholson, a Milleporid. I am unable to offer an opinion as to the alliance of *Stromatopora* and its congeners to the Milleporidæ, on which Mr Carter[1] insists, since I have as yet had no opportunity of studying the structure of these fossils. If *Stromatopora* is a Milleporid, the family dates back to Silurian times. Dr Dawson[2] is opposed to Mr Carter's conclusions, to which, nevertheless, I am, from the evidence adduced, inclined to adhere. Mr Carter[3] has described a species of *Millepora*, *M. woodwardi*, as occurring in the lower chalk. Apparently no older representative of the genus is known.

### Vegetable Parasites of the Milleporidæ.

In my paper On the Structure of *Heliopora cærulea* (Phil. Trans. Roy. Soc., vol. lxvi. part 1, p. 116) I described certain vegetable parasitic organisms as found in the tissues of *Millepora* and *Pocillopora*. These organisms have been made the subject of memoirs by Professor Martin Duncan,[4] who summarises the results obtained by Leuckart, the original discoverer of these parasites in 1851, and subsequent observers, such as Dr Carpenter (Bowerbank), Wedl, and Kölliker. The parasites are of essential interest since they occur in deep-sea corals, and are, as far as is yet known, the only vegetable organisms occurring at great depths. Professor Duncan refers them to the genus *Achlya* (*Saprolegnia*). Both a species of *Millepora* obtained at Samboangan, in the Philippine Islands, and the *Millepora nodosa* of Tahiti were found to be infested by these parasites.

[1] *Loc. cit.* Also, On *Stromatopora*, Ann. and Mag. Nat. Hist., vol. ii. p. 85, 5 ser., 1878. On the probable nature of the animals which produced the Stromatoporidæ traced through *Hydractinia*, *Millepora alcicornis*, and *Charnopora* to *Stromatopora*, *ibid.*, vol. ii. p. 304, 5 ser. On the Mode of Growth of *Stromatopora*, *ibid.*, vol. iv. p. 101, 5 ser., 1879. On the Structure of *Stromatopora*, vol. iv. p. 353, 5 ser.

[2] *Stromatopora* as distinguished from *Millepora*, Ann. and Mag. Nat. Hist., vol. xix., 4 ser., 1877.

[3] On new species of Hydractiniæ and on the identity in structure of *Millepora alcicornis* and *Stromatopora*, Ann. and Mag. Nat. Hist., vol. i., 5 ser., 1878.

[4] Professor P. Martin Duncan, F.R.S., On some Thallophytes parasitic within recent Madreporaria, Proc. Roy. Soc., No. 174, 1876, p. 238; On some Unicellular Algæ parasitic within Silurian and Tertiary Corals, &c., Quart. Journ. Geol. Soc., May 1876, p. 205.

The hard tissues are transversed in all directions by fine capillary branching canals which are provided at intervals with numerous spherical cavities attached to them laterally (Pl. XIV. figs. 6, 8). In *Millepora alcicornis*, from Bermuda, in which the cœnosteum is comparatively soft and cancellar, borings of the parasites could only here and there be detected. When set free by acids the organisms are seen to consist of ramifying mycelial threads, with abundance of fructification. Their structure has been described at length by Professor Duncan. It is remarkable that they have a distinctly green colour. They are not confined to the calcareous structures, but in *Millepora nodosa* at least, occur also in abundance amongst the soft superficial tissues; and it appears probable that they become included within the calcareous tissue by the calcareous matter being deposited around them as the cœnosteum is extended by growth.

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## SECTION II.—ON THE STRUCTURE OF THE STYLASTERIDÆ.

### WITH A LIST OF ALL THE SPECIES OF THE FAMILY AT PRESENT KNOWN, AND DESCRIPTIONS OF SOME NEW SPECIES OBTAINED BY H.M.S. CHALLENGER.

#### Introduction.

In the Proceedings of the Royal Society, No. 172, 1876, I published a preliminary note on the present subject, and gave a short account of the results which I had arrived at from a somewhat hurried examination of the material at disposal. After this short account had been written, I devoted my time during the remainder of the homeward voyage of H.M.S. Challenger to the further study of the structure of the Stylasteridæ, and the preparation of drawings illustrating it; I have supplemented this by additional work in England, and the results are embodied in the present paper.[1] The main part of the specimens of Stylasteridæ, from the study of which the anatomical details were determined, was obtained at a single haul of the trawl-net taken on February 14th, 1876, in lat. 37° 17′ S., long. 53° 52′ W., off the mouth of the Rio de la Plata, in a depth of 600 fathoms. The specimens then obtained included six genera of the family Stylasteridæ. They were in most excellent preservation, although they had been slowly raised from the bottom, and in all the genera but one the generative organs were in full

[1] The greater part of this present treatise is a reprint of the Croonian Lecture for 1878, On the Structure of the Stylasteridæ (Phil. Trans. Roy. Soc., part 2, 1878, p. 425), which was published in advance in the Philosophical Transactions by the permission of the Lords Commissioners of the Treasury.

development. It was the examination of this set of specimens which first convinced me that the Stylasteridæ were Hydroids and not Anthozoans, a fact which I had already been led to suspect from the structure observed in the case of a species of *Astylus* obtained from 500 fathoms off the Meangis Islands, and that of a *Cryptohelia*, a short reference to which was given in a paper On the Structure and Relations of Certain Corals (Proc. Roy. Soc., No. 64, 1875, p. 64, and Phil. Trans., vol. clxvi., part 1, 1876, p. 116). I have examined also other specimens of Stylasteridæ obtained by the dredge and trawl of the Challenger in various parts of the world, and a few specimens from those obtained by the United States' dredging expeditions, which have been generously placed at my disposal by Mr Alexander Agassiz and Count de Pourtalès of the Museum of Comparative Zoology of Cambridge, Massachusetts. I have also examined specimens of *Distichopora* preserved in spirits, which I obtained from the Museum Godeffroy.

## Literature of the Subject.

The family Stylasteridæ was formed by the late Dr Gray in his Outline of an Arrangement of the Stony Corals (Ann. and Mag. Nat. Hist., vol. xix. p. 127, 1847). The family was made to contain the genus *Stylaster* alone, and was thus characterised :—

"Coral minutely porous, cells deep, cylindrical, with six grooves, each ending in a pore and a central style."

MM. Milne-Edwards and Haime placed *Stylaster* in a sub-family Stylasteraceæ, from which, however, they excluded *Errina* and *Distichopora*, although they included *Axohelia*, which is a *Madracis*.

Count de Pourtalès, in his Deep-Sea Corals (Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College, No. 4, 1871, p. 33), writes as follows :—

"Professor Verrill first recognised the close affinity of *Distichopora*, *Errina*, and *Stylaster* (Bull. Mus. Comp. Zool., No. 3, 1864). In his Notes on the Radiata (Trans. Conn. Acad., vol. i., 1870) he adopted a suggestion of mine to make a distinct family of the Stylasteridæ, which he places in his sub-order Oculinacea, both of us overlooking the fact that Gray had already established it."

Pourtalès, struck by the porous nature of the cœnenchym of the cœnostea of the Stylasteridæ, and other points in the hard structure which he observed, removed the Stylasteridæ from amongst the imperforate corals, and ranged them next to the Eupsammidæ. He fully recognised many strong points of affinity which rendered the family a natural one, but failed to ascertain the true character of the organisms, because he had not opportunity of examining their soft structures.

The cœnostea of several species of the family have been known to science from early times. The earliest known species, according to MM. Milne-Edwards and Haime, seems to have been *Stylaster flabelliformis*, the *Corail blanc* of Seba (Thesaurus, iii. 204, pl. cx. fig. 10, 1758), while *Stylaster roseus* and *Distichopora violacea* were described under the general genus *Madrepora*, by Pallas, in 1766.

Gray gave the name *Stylaster* to the genus in 1831 (Zool. Miscell., p. 36), and described the genus *Errina* in 1835 (Proc. Zool. Soc., 1835, p. 35). *Distichopora* was named by Lamarck, *Allopora* by Ehrenberg in 1834, and *Cryptohelia* was described by MM. Milne-Edwards and Haime in 1849.

Pourtalès has added a new genus to the family, viz., *Pliobothrus*, as one of the results of the United States' deep-sea dredging operations, and Saville Kent another, *Stenohelia*, whilst I have added five genera, viz., *Sporadopora*, *Spinopora*, *Conopora*, and *Astylus*, dredged by H.M.S. Challenger, and *Labiopora*, wrongly described by Gray as a Bryozoon under the name *Porella*.

Dr Edward Gräffe of Zurich found a species of *Distichopora* living at Fiji. It grows only on the outermost reef border of Ovalau Island, close to the surf, attaching itself in dark hollows in old dead Madrepore blocks. It never grows in the light, and is rapidly bleached by the action of sunlight. Gräffe observed the large round cells in the ampullæ, and conjectured that they were ova, but he could not obtain a view of the zooids, although he examined specimens brought fresh from the sea. He concluded that *Distichopora* was probably a Bryozoon.[1]

The only extant account of the soft parts of any Stylasterid is that of the animals of *Allopora norwegica* by G. O. Sars.[2]

Sars kept a succession of living specimens of the coral in fresh sea water, but never got the animals to expand so as to raise themselves above the level of the stellate openings. Nevertheless he saw clearly with lenses the tips of the opaque white tentacles in the angles between the so-called incomplete septa, which tips were usually more or less bent inwards towards the centre. He also saw deep down in the bottom of the calicle a similarly opaque white knot-shaped projection. This was all that could be seen in the fresh living animals. Specimens were, however, preserved in spirit and subsequently examined, and the conclusion was come to that the animal was essentially different from the rest of corals, and probably did not belong to the Anthozoa at all, but rather to the Hydrozoa.

By means of lucky breakings through of the stony-hard but nevertheless porous coral, Sars was able to obtain some little view of the general form of the polyps and their

[1] Dr E. Gräffe, Notizen über die Faune der Viti Inseln. Verh. und der K.K. Zool. Bot. Gesell in Wien, xvi. Bd., 1866, 1585.

[2] G. O. Sars, Bidrag til Kundskaben om Dyrelivet paa vore Havbanker. Forh, i Videnskabs Selskabet, i Christiana, 1872, p. 115.

relation to the coral. The true polyp body, he says, lies at the bottom of the central cavity of the calicle. It is very small, almost hemispherical in form, and provided with an apparently protrusible beak or proboscis, which is sharply defined and bluntly conical in form, and on which no mouth opening was observable. From the circumference of the head of the polyp proceed the narrowly cylindrical tentacles which correspond in number to the infoldings of the calicle. Their lower region is inserted in the interseptal canals, while their upper parts project free from the foldings in between the so-called septa, and usually bend with their bluntly rounded ends towards the centre. No distinct connection between the different polyp cavities was to be observed. They all seemed completely closed below; but it is to be remarked that the whole upper lining part of the coral is highly porous. Often there were to be found outside real polyp cavities in the inner mass of the coral near the surface, small cavities apparently everywhere closed, wherein were included one or several spherical bodies (eggs ?). Portions of the coral were decalcified in acetic acid. The organic basis remaining preserved to a considerable extent the form of the coral, and was composed of a tolerably regular network of apparently fibrous tissue in which were embedded numerous small elliptical nematocysts. The body of the polyp could be prepared out with considerable ease from this mass in connection with its several tentacles, which under the microscope showed themselves beset all over with extremely small tightly-packed nematocysts.

Although Sars thus suspected the affinity of the Stylasteridæ to the Hydroida, his results were insufficient to demonstrate the fact, since he could obtain no satisfactory information concerning the generative structures of the coral which he studied, and he failed entirely to detect the compound nature of the cyclo-systems of *Allopora*, since he regarded the dactylozoids as the tentacles of the gastrozooid, or body of the polyp, as he terms it. He, however, determined a great deal which was of high value. He was the first to make any observations on the structure of the soft parts of the Stylasteridæ, and is as yet the only naturalist who has watched a Stylasterid in the living condition.

He concludes his account with the following words, which show that he was not certain as to the true nature of *Allopora*, although he considered there were strong grounds for removing it from amongst the Anthozoa :—

"Af det allerede anforte synes imidlertid med sikkerhed at fremgaa, at vi her have for os en Dyreform der i mange væsentlige Punkter afviger fra Anthozoerne hvortil den maaske slet ikke engang kan henføres."

## Methods Employed.

The methods employed in investigating the structure of the Stylasteridæ were mostly similar to those made use of in the case of *Millepora*.

A brief examination of some of the soft structures of certain of the Stylasteridæ was made while they were in the fresh condition, and especially of the various elements of *Sporadopora dichotoma* and of the female gonophores of *Cryptohelia*; but since the trawl-net by which most of the specimens available for examination were obtained came up late in the day, very little, unfortunately, was able to be done in this way.

Portions of the corals were preserved by means of chromic acid, osmic acid, absolute alcohol, and glycerine, and they were subsequently decalcified and examined in the usual manner by means of sections. In cutting the sections, a method described by Milchalkovics, Arch. für mikroskopische Anatomie, ii. Bd. 3$^{tes}$ Hft., p. 386, was adopted and found to yield most successful results. The method is especially valuable for cutting fine sections of structures, the parts of which are loosely held together, and where it is desirable to maintain the exact relations in position of parts which in the sections otherwise become entirely disconnected from one another. A strong jelly composed of equal parts of glycerine and gelatine is used as an imbedding substance. It permeates the tissues and takes the place of the hard calcareous supporting structures which have been removed by the acid. The sections are mounted in glycerine, and the imbedding substance which is left *in situ* in the sections becomes perfectly transparent; in fact, almost invisible in this fluid. No doubt Dr von Koch's method referred to above will yield valuable results in the future.

## Structure of the Hard and Soft Parts in the several Genera of the Stylasteridæ.

I now proceed to a detailed description of the structure of the several genera of the Stylasteridæ.

Each of the members of the family is composed of hard inert calcareous parts, or cœnosteum, and soft living structures. In the case of each genus the structure of the hard parts will be first treated of, and then that of the soft parts. The latter consists of cœnosarc, zooids, and gonophores, and will be described under these several headings in each case. A full description of all details will be given in the case of *Sporadopora*, which will be first accounted for, and in the cases of the other genera only those points in which they differ from it will be dwelt upon.

## *Sporadopora*, Moseley.

This genus, hitherto unknown, I described in the Proceedings of the Royal Society, vol. clxxiii., 1876, p. 94, under the name *Polypora*, but as I was informed by Mr Etheridge, junior, that the name *Polypora* was already in use, I changed it to *Sporadopora*, which refers to the irregular scattering of the pores over the surface of the cœnosteum. The genus is founded on a single species, *Sporadopora dichotoma*, obtained on one occasion only by the Challenger off the mouth of the Rio de la Plata in 600 fathoms.

### Cœnosteum of *Sporadopora dichotoma*.

The cœnosteum or hard calcareous structure in this Hydroid occurs in the form of stout upright stems, which branch with tolerable regularity dichotomously to form a flabelliform expanse. The stem is usually nearly circular in section towards its base, but becomes compressed above in the plane of the fan, whilst the branches and branchlets forming the fan itself are very much flattened, so as to be more oblong than oval in transverse section. The number of branchings is few, only four or five at most. The flattened branches and branchlets coalesce at their adjacent margins. A figure of a well-grown but partly broken example is given on Plate I. fig. 2, reduced to half the natural dimensions.

Sometimes the stems are somewhat bent and irregular, as are also the flabellate expanses which they support. The height of the largest specimen obtained is about $5\frac{3}{4}$ inches, and the breadth of the fan about 5 inches. The diameter of the stem at its base is about 1 inch; in more slender specimens $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. In one large broken and dead specimen the stem is 2 inches in diameter. The cœnosteum is dense and heavy, and when macerated out from a living specimen is of a pearly white, and smooth and glistening in appearance (Pl. I. fig. 1). The surface is pierced by deep pores, which are simply circular in outline and of two kinds, large and small, and are scattered irregularly over it. The larger pores or gastropores are less numerous than the smaller. They are deep, reaching nearly to the central axis of the branch or stem on which they are situated, and contain a deep-seated, long, and slender style. The smaller more numerous pores, the dactylopores, are thickly dispersed between the larger ones. They have no style. The pores are usually more abundant on one face of the coral flabellum than on the other; indeed, large areas of what may be called the back of the stem are often devoid of pores altogether.

The appearance of the surface of the cœnosteum as seen by reflected light under a low magnifying power is shown in Plate II. fig. 2. The surface presents slight irregular undulations. Its texture is somewhat like that of loaf sugar, being composed of closely

apposed minute glistening white granules. The margins of the mouths of the dactylopores are often slightly raised above the general surface.

The older pores of the cœnosteum are very deep and, as may be seen in longitudinal sections of the branches or stems (*t.o.*), commence deep down within the stem near its axis, and bend outwards on all sides to the surface of the branch with a nearly uniform curve. The cœnostea of all Stylasteridæ are traversed in all directions by a system of freely anastomosing and branching canals. In the case of *Sporadopora*, these canals are especially abundant and form comparatively close meshworks, hence the whole cœnosteum is spongy and excessively porous when seen in section (Pl. II. fig. 1). The cœnosteum may, with most truth, be said to be built up of a series of hard partition walls, intervening between and enclosing a highly complex system of tortuous canals and cavities. The meshwork formed by these canals is closer and smaller towards the surface of the cœnosteum, more open and with wider meshes in the deeper regions. In the deeper regions the main canals, as will be seen from the figure, follow more or less the curved directions taken by the walls of the pores on their way towards the surface. There is no main system of canals in the axis of the stem connecting all the zooid cavities. The deep canals become more or less filled up, and the only connection between distant zooids is by the more superficial living meshworks. In some places irregular cavities of some extent occur amongst the smaller canals, and beneath the ampulla (Pl. II. fig. 1, G). At the very surface, the canal reticulation is very fine indeed.

The pores are cylindrical pits sunk in the spongy mass of the cœnosteum, and their walls are perforated all over by the openings of numerous canals. At their bottoms their cavities pass off into a few large main canals of the meshwork. The styles of the gastropores are very long, and can be traced deep into the axes of the branches of cœnosteum, they having become elongated as the growth of the pores and cœnosteum required it. In their deeper regions, these slender styles show a surface composed of a few dentate ridges (Pl. XXXV. fig. 1, S) only, whilst in their upper and functionally active region they terminate in a long brush-like mass, composed of complicated branchings of fine and delicate calcareous spicules. At the base of this brush-like part of the style, a very thin calcareous partition or "tabula" (Pl. II. fig. 1, T) is sometimes present, stretched across the pore cavity at right angles to its axis. Sometimes two or three such tabulæ are present in a single gastropore, placed at successively deeper intervals. In some instances, two tabulæ occur close together in a pore, one above the other. These tabulæ are so excessively thin that I considered them at first to be membranous, but I have been unable to dissolve them by the use of very strong alkalis, and I am now convinced that they are calcareous. They do not seem to occur in all the gastropores, and I have not observed them in any instance in the dactylopores. The dactylopores vary much in size, as will be seen from the figures.

Spheroidal cavities occur excavated in the cœnosteum at a very slight depth from the surface. These contain the gonophores in the recent state of the coral, and may be called ampullæ. They are in this genus entirely buried beneath the surface, whereas in most genera of Stylasteridæ they project above it often to a very conspicuous extent. They communicate with the exterior when mature by means of small slit-like apertures placed at the bottoms of small irregularly shaped depressions which are to be seen with some difficulty scattered over the coral surface (Pl. II. fig. 2, GG). Only male specimens of *Sporadopora* have been obtained as yet. No doubt, in the case of ampullæ containing female gonophores, a comparatively wide opening in the surface of the cœnosteum is formed to allow of the escape of the fully formed planula.

This actual tissue of the cœnosteum must be in *Sporadopora* and in most other Stylasteridæ excessively dense and compact, since the masses formed by it, although, as described, excavated by canals in all directions, are heavy.

In the older parts of the stems and their bases, the cœnosteum appears to become compact and stony, and crystalline in fracture by obliteration of the canals and pores. In some specimens, portions of the surfaces of the stems which have once been dead have undergone rejuvenescence by the spreading of a thin layer of living coral over them from adjacent healthy regions.

The dead cœnostea are overgrown by a *Flustra* and other Bryozoa, and form bases of attachment to large masses of other Stylasteridæ, such as *Errina labiata*.

Since the calcareous meshwork is closer at the surface of the cœnosteum, its meshes must necessarily become enlarged by reabsorption as growth proceeds. Cavities also such as those of the ampullæ must be filled up as the cœnosteum grows. The irregular cavities existing beneath the ampullæ in some cases, as shown in Plate XXXV. fig. 1, probably represent spaces occupied in an earlier condition of the coral by gonophores. Sometimes also old ampullar cavities remain unfilled up, situate beneath the more superficial and active ones.

The tissue of the cœnosteum is very like that of *Millepora* in histological structure, but appears somewhat more granular in texture, and less fibro-crystalline than it.

### Soft structures of *Sporadopora dichotoma* (Pl. III.).

*Cœnosarc.*—The tortuous canals and pores by which the cœnostea of all the Stylasteridæ are traversed, are occupied in all the genera alike, in the living condition of the coral, by a series of meshworks of correspondingly branching, twisting, and anastomosing canals, which compose the cœnosarc or common body of the compound organism in each case. In *Sporadopora* only a comparatively thin layer on the surface of the coral is occupied by living soft structures. These living structures are separated from the non-living deeper masses of the cœnosteum by the action of acids, and then appear as a sheet of soft

tissue composed of cœnosarcal meshwork zooids and gonophores, which may be called the living lamina.

The canals of the cœnosarc are composed of a very thin and transparent membranous wall, covered on the outer surface by a layer of ectoderm cells, and on the inner lined by endoderm cells. In general structure the canals closely resemble those of the cœnosarc of *Millepora* as described and figured in the first part of this memoir.

The ectoderm layer covering the cœnosarcal canals varies much in thickness, being thickest in the more superficial parts of the cœnosarcal meshwork. I was, unfortunately, unable to examine its structure in the fresh condition, because the trawl by which the specimens of *Sporadopora* and of most of the other genera were obtained came up late in the day, and the short daylight available sufficed only for the investigation of more important matters.

Although a definite cell structure is not to be made out everywhere in the ectoderm of the cœnosarc, as for example in the surface layer of the coral, it seems probable from the appearances presented by specimens hardened in osmic acid that such characterises it throughout. The layer investing the canals is mainly composed (Pl. XI. fig. 13) of transparent inflated nucleated cells which vary in size, so that the stratum is in some places two cells thick, in others only one. Amongst these cells occur nuclei and certain cells in which nematocysts of two kinds to be presently described are contained in various stages of development.

The calcareous matter of the cœnosteum must be secreted by this ectodermal layer of the cœnosarcal canals, but I have not been able to observe how this takes place, or whether by means of any particular form of cell.

In the membranous layer of the canals no structure was detected. The endodermal lining of the canals is composed of abundance of spheroidal pigmented cells, containing a nucleus and granules of pigment of various sizes, and closely similar in appearance to those occurring in *Millepora*. The pigment in the present species is of a brick-red colour. Besides these cells, smaller transparent, colourless, spheroidal cells occur in the endodermal layer, and also free pigment granules and effete pigment cells, devoid of granular contents (Pl. XI. fig. 14). The arrangement of these several constituents of the endoderm within the lining of the canals was not determined. No doubt in all the Stylasteridæ the inner surface of the canals is, as usual, ciliated, although cilia were not able to be made out in any case, owing to the action of reagents on the tissues.

As will be seen by reference to Plate III., the cœnosarcal canals form in *Sporadopora* a very complex network, which brings, by means of the freest anastomoses in all directions, the several members of the compound organism into complete circulatory connection with one another.

The interspaces in the meshwork, occupied in the recent condition of the coral by hard masses of the cœnosteum, are larger and wider in the deeper regions of the cœnosarc than

nearer to the external surface; for here the meshwork is much closer, and the mass of soft living tissue much greater in proportion to the calcareous structures secreted by it, than is the case in the deeper regions. Further, the deeper canals are of greater calibre than those nearer the surface. Towards the deepest regions of the cœnosarc the canals are shrunken and atrophied, and pass off into effete and almost dead fragments of tissue, which form the inner boundary of the living lamina.

The largest trunks of the meshwork are those which proceed directly from the bases of the zooids and gonophores. These are soon reduced in size by branching, and are lost in the general anastomosis.

Around the sacs containing the zooids the canals of the cœnosarc have a special radiate disposition (Pl. X. fig. 3). The radial canals occupy an area circular in outline extending all around the outer sides of the sacs of the zooids. They pass directly inwards radially, from the margins of the areas where they take origin from the general meshwork to join themselves on to the walls of the zooid sacs, towards the centres of the areas. They branch but seldom on their course, and then only towards their outer origins where they not uncommonly bifurcate.

As may be seen from the figure, the radial canals, which lie at successive depths from the surface, do not correspond in any way in position with those above or below them, but are quite irregular as far as radial disposition is concerned. In vertical sections, however, of the living lamina (Pl. III.), these radial canals are seen to succeed one another at tolerably regular intervals, in vertical disposition, with a somewhat regular series of interspaces between them.

This radial disposition of the canals is less marked around the sacs of the larger dactylozooids than around those of the gastrozooids, and is hardly apparent around those of the smaller dactylozooids. Traces of it are to be seen around the sacs of the gonophores, as at G′, Plate XXXVI. Although towards the periphery of the area occupied by them these radial canals contain endoderm cells, and appear similar in structure to the other canals of the cœnosarc, towards their inner extremities, where they join the zooid sacs, they become diminished in size, and often appear as mere slips of transparent tissue having a fibrillate appearance.

Muscular filaments, continued from ovoid muscular cells embedded in the walls of the zooid sacs, pass outwards along the radial offsets, and are attached to them in the region about the mouths of the sacs (Pl. X. fig. 3, R M).

Attached to the radial offsets, and often extending over the interspaces between adjacent ones, slips of a fine transparent membrane, containing minute nuclei and striated in appearance as if composed of fine fibrillæ, are constantly to be seen; but they seem to occur at altogether irregular intervals, and only towards the more superficially lying parts of the zooid sacs (Pl. X. fig. 3; Pl. III. AA).

A continuous layer of ectodermal tissue extends over the outer surface of the coral.

No distinct cell structure was made out in this surface layer in *Sporadopora*, although such probably exists, as it was clearly seen in the case of the surface layer of *Errina labiata*. The layer bridges over the gaps in the superficial meshwork of the cœnosarcal canals, and portions of it close in the mouths of the sacs of the zooids when the latter are in the retracted state. Over the mouths of the sacs and radial canals of the retracted gastrozooids these special parts of the surface layer appear as discs of membrane, with very small apertures in their centres, and showing a radial fibrillation diverging from these central openings which seems as if caused by contraction of the tissue in order to close the aperture.

Embedded in the surface layer are numerous nematocysts of two kinds, larger and smaller. These are figured in Plate X. fig. 9. The larger nematocysts are in the form of cylinders, very slightly bent. Their ends from which the threads are shot are bluntly pointed, whilst their opposite extremities are rounded. The thread at rest is coiled up spirally within the cell, in the usual manner (Pl. X. fig. 9, *a*). The emitted thread has, near the cell, an elongate enlargement, which is beset with a spiral of spines (*a'*). The remainder of the thread is simple. These larger nematocysts have a length of about ·0016 of an inch.

The smaller kind of nematocysts are of an ovoid form, slightly flattened on one side, and, like the larger kind, more pointed in shape towards the end from which the thread emerges. They measure ·00064 of an inch in length. They have a small bladder-like enlargement on their emitted threads, but it is, as far as was ascertained, devoid of spines.

In both kinds of nematocysts the threads are shot out, not in a line with the length of the cell, but at a slight angle to this, and in continuation of the curves of the cells.

Thread cells of almost exactly similar structure to these two occur in all the genera of Stylasteridæ, the soft parts of which are described in the present paper.

The nematocysts are developed in transparent cells of the ectoderm, which always contain a nucleus of finely granular appearance. The young nematocyst is seen developing within the cell with the nucleus lying beside it, and in proportion as the nematocyst increases in size and maturity the nucleus diminishes in bulk (Pl. X. fig. 9, *c*, *d*, *e*).

Nematocysts of both kinds are to be seen in abundance in all stages of development in the ectodermal cells of the more superficial regions of the cœnosarcal meshwork. Both larger and smaller nematocysts are present in abundance, scattered in the superficial layer of the ectoderm.

The larger form of nematocysts also occur in well differentiated nematophores, which occur disposed irregularly amongst the zooids in the superficial region of the coral (Pl. III. N N). The nematophores are irregularly semicircular in vertical section, with the flat side of the semicircle coinciding with the surface of the superficial layer of the ectoderm. Except on this flat side they are bounded by a membranous wall, which

forms a sac open above. The open mouth of the sac is crammed with nematocysts of the larger kind, closely packed side by side, with their pointed ends directed to the surface. The cells are so closely packed that, in a section of the superficial layer taken parallel to the surface through the nematophores, no interstices can be seen between them (Pl. X. fig. 3, N). The lower part of the cavity of the nematophore is filled with nuclei and parent cells of the nematocysts. The nematophores, as viewed from the surface of the superficial layer, are seen to have an irregular outline, showing a tendency to be somewhat oblong, with curved boundaries.

No triple-spined nematocysts, such as those occurring in *Millepora* and in most other Hydroids, were detected as existing in any of the Stylasteridæ. The two kinds described as occurring in *Sporadopora dichotoma* appear to be present in all members of the family, with very slight variations in form indeed.

*Dactylozooids.*—The dactylozooids are in all the Stylasteridæ invariably destitute of tentacles, being reduced to the condition of simple tentacles themselves, and evidently performing a tentacular function.

*Zooids.*—The zooids in *Sporadopora dichotoma* are of two kinds, dactylozooids and gastrozooids: the former occupying the smaller, and the latter the larger, style-bearing pores, already described as characteristic of the corallum.

They are closely similar in form and structure in all the genera of Stylasteridæ hitherto examined, and differ only in dimensions. They are simple, elongate, conical bodies, just like the ordinary tentacles of Hexactinians in form, and are devoid of mouth or any opening to the exterior. They are attached to, and, when unprotruded, retracted within membranous sacs or sheaths which rest within the corresponding pores of the corallum. In *Sporadopora*, the sacs of the zooids, the walls of which are shown in longitudinal section in Plate III. F F, are composed of a transparent membrane, derived from the ectoderm, and continuous with its surface layer. The membrane has numerous fine nuclei dispersed in its substance, and is strong and tough. It is lined on its inner surface next the cavity of the sac by a layer of small transparent cells, which are shown in the figure cited above.

On their outer surfaces the walls of the zooid sacs are abutted on by the peculiar radial offsets of the cœnosarcal meshwork already described. These offsets appear to lose their tubular character as they near the walls of the sacs, and, as far as was seen, no openings occur in the sac walls communicating by means of these radial canals with the cœnosarcal circulation, although such an arrangement was supposed to exist when the first hasty examination of specimens was made.

The sacs are attached to the bases of the zooids, being continuous in those regions with the ectodermal covering of the zooids. They closely invest the retracted zooids, and are thus cylindrical in form in their deeper parts; whilst above the level of the retracted zooids they contract gradually in diameter, to terminate at the surface of the

coral in small openings, which are usually seen to be quite closed by contraction of the surrounding superficial membrane in hardened specimens. The sacs lie loose within the pores of the cœnostea; that is, they are smaller in diameter than their containing calcareous cavities, but they are held in place by the attached radial offsets of the cœnosarc, which issue from the numerous openings in the walls of the pores to join on to them (Pl. II. fig. 1, G Z).

The dactylozooids of *Sporadopora* vary much in size, the smaller being of less than half the dimensions of the largest. They are elongate-conical in form, and are composed of an ectoderm, endoderm, membranous and muscular layers. They have an axial tubular cavity within, which communicates directly at their bases with the larger deeply-situate canals of the cœnosarcal meshwork.

The ectoderm forms, in the retracted zooids, a thick external layer, which is thrown by the contraction of the zooid into a series of transverse folds (Pl. III. D Z. No doubt, in the expanded condition of the zooid the ectoderm would appear much thinner. The outer surface of the layer is thickly beset with nematocysts of the smaller variety, which are so closely packed side by side, with their pointed ends outward, that in the retracted zooid no interstices between them are to be made out (Pl. X. fig. 2, E). Beneath this armature of nematocysts the main thickness of the ectodermal layer is composed of finely granular matter filled with ovoid nuclei and nematocysts, in various stages of development. No definite cell-structure could be determined in the layer, but fine lines, having a radial disposition in transverse sections of the zooid, seemed to indicate that the layer is composed in reality of somewhat prismatic cells, disposed in it radially to the central axis of the zooid.

At the inner surface of the ectoderm is a layer of very distinctly differentiated muscular slips, which have a longitudinal disposition (Pl. X. fig. 2, M; Pl. X. fig. 3). These muscular slips do not form a quite continuous layer, being separated from one another, as appears in transverse section, by a definite series of intervening spaces. These muscles are fine and difficult to detect towards the tips of the zooids, but increase in thickness towards their bases. In these regions of the zooids they are extremely conspicuous, and spread out in a thick layer over the large main vessels of the cœnosarc in immediate connection with the bases of the zooids, passing beneath the ectoderm of these canals, and being inserted into their walls. These muscles act evidently as the retractors of the zooids. Since they are more highly developed in the case of the gastrozooids, they will be further described when these are under consideration.

United with the muscular layer and inseparable from it, is a layer of membrane which is continuous with the membranous layer of the cœnosarcal canals, and forms a complete sac within the zooids. This basement membrane shows, in the contracted zooids, a transverse striation (Pl. X. fig. 6), which was at first supposed to indicate the existence of a layer of circular muscular fibres crossing the described longitu-

dinal muscles. No definite circular fibres could, however, be detected, and the appearance is probably due to contraction of the membrane.

The inner surface of the membrane is lined by endodermal cells. In the contracted zooid, these form a layer two, three, or four cells thick. The cells are globular, clear, and transparent, and contain a nucleus (Pl. X. fig. 2; Pl. III.). On the actual inner surface of the layer, bounding the zooid cavity, is a layer of cells similar in character to, but much smaller than, those composing the main mass of the endoderm. No doubt the inner surface of the cavity of the zooid is ciliated in the living condition; cilia were, however, not detected. Towards the base of the zooid cavity, the transparent cells are replaced in the endoderm by the spherical pigmented cells, which are the principal constituent of the endoderm of the cœnosarc.

The dactylozooids have a tendency to be attached by their bases to one side of the bottoms of their sacs, rather than to the lowest extremities. When this is the case, as in Plate III. DZ, the zooid in the retracted condition is partly doubled up upon itself, and not merely drawn directly in. The main retractor muscles, however, pass almost directly downwards to their insertion into the cœnosarcal canals. In consequence of this arrangement the bottoms of the sacs are, when it occurs, pulled somewhat to one side. This form of attachment of the dactylozooids occurs mostly amongst the larger examples, no doubt because their greater length requires such an arrangement in order to allow of more complete retraction by the aid of the doubling of the zooid. This tendency to lateral attachment in the dactylozooids, as occurring in *Sporadopora*, where the zooids are diffusely scattered over the coral surface, is of interest, because the same tendency is shown by the dactylozooids in nearly all the Stylasteridæ; and in some, as in *Cryptohelia*, *Allopora*, &c., it is the normal and only method of attachment.

*Gastrozooids.*—The gastrozooids in *Sporadopora dichotoma* are cylindrical in form, with four short tentacles set on to the body equidistantly in a single whorl. Above the line of origin of the tentacles rises the dome-like hypostome, which in the retracted condition of the zooids has a height equal to that of about one-third of the entire height of the zooid body.

The zooid in its inferior region is circular in section, but superiorly, in the region where the tentacles are given off and in that of the hypostome, it assumes, in section, the form of a rectangle with the corners rounded off and the sides indented, the tentacles being situate at these corners of the rectangle.

Within the zooid is a wide gastric cavity, into the axis of which, in the retracted condition of the zooid, the calcareous style of the gastropore protrudes for two-thirds of the height of the cavity (Pl. III. *St*).

The mouth at the summit of the hypostome appears when viewed from above as a cruciform opening leading directly to the gastric cavity. The gastric cavity communi-

cates by tubular offsets with the axial cavities of the tentacles, and at the periphery of its base it becomes continuous with the cavities of four large canals. These canals subdivide almost immediately into smaller trunks which anastomose with the general cœnosarcal meshwork.

The gastrozooids are structurally composed of the same number of layers as the dactylozooids. The ectoderm forms on these zooids a somewhat thinner layer than on the dactylozooids. Definite cell structure was not made out in it. It is, however, full of nuclei, and is no doubt definitely cellular in the living condition. It is not, as in the case of the dactylozooids, thickly beset with nematocysts, but contains very few of these bodies (Pl. X. figs. 1 and 5).

On the inner surface of the ectoderm, in combination with the basement membrane, occurs a muscular layer which is very highly developed. The layer is composed of a series of longitudinally disposed muscular slips, which are set side by side with narrow interspaces, so as to form a thick layer (Pl. X. fig. 6). This layer is extremely thick and dense towards the base of the zooid, as will be seen from Plate III. M, and becomes gradually thinner and less conspicuous towards the hypostome. The muscular slips are stout and closely set towards the base of the zooid, and are prominent objects in transverse sections of it in that region (Pl. X. fig. 5), whilst they are widely separate and fine and far less numerous towards the upper regions of the zooid (Pl. X. fig. 1, M), where little is to be seen but the transparent basement membrane. The muscular slips are composed of very distinctly differentiated cells which have mostly a fusiform shape (Pl. X. fig. 8), with the tails of the cells usually somewhat bent. Many cells are found to occur amongst the mass which are apparently in the act of division, two fusiform bodies being connected together by a string, or broad mass, of protoplasm. Such cells are so numerous that possibly a considerable proportion of the muscular elements remain permanently in this compound condition. The cells are closely fitted together side by side to form the muscular slips which, where most developed, have a breadth of three or four cells (Pl. X. fig. 7).

The longitudinal muscular slips pass from the basis of the zooids to spread out beneath the ectoderm of the four main canals of the cœnosarc in which the cavities of the zooids terminate inferiorly.

Fused with the muscular layer occurs, as in the dactylozooids, a continuous layer of membrane. This basement membrane is transparent, and the only structure which I have seen in it is a striation transverse to the longer axis of the zooids, which, as already stated in reference to the dactylozooids, I at first believed to give evidence of the existence of circular muscular fibres in the zooids. Such fibres I have, however, been unable to discover on closer examination.

Beneath the membranous layer lies the endoderm. This is composed, towards the

upper region of the zooid and in the hypostome, of elongate ovoid cells, with an inflated appearance, very transparent, each containing a small nucleus. These cells, as is well seen in transverse sections (Pl. X. fig. 1, G), are packed side by side to form the endodermal lining of the zooid, with their longer axes directed inwards, radially, towards the axis of the zooid, except towards its uppermost region where the direction of these cells is modified by the peculiar rectangular form assumed by the zooid. These elongate cells are closely similar to those occurring in a similar situation in other Hydroids, and there can be little doubt that they are gastric in function. It will be observed that they do not occur in the endoderm of the mouthless dactylozooids. Towards the base of the zooid cavity, these cells become shorter and shorter in length, until in the deepest regions they become mere small globular transparent cells, like those composing the endoderm of the dactylozooids. Towards the base of the zooid they are further overlaid by a layer of the pigmented endoderm cells, which form the endodermal lining of the general cœnosarcal meshwork. The lining of the cœnosarcal canals thus becomes continuous with that of the zooid cavity (Pl. III.).

The calcareous style projecting up into the cavity of the zooid has reflected over it from its base a covering of ectoderm, and over that it is protected within the zooid cavity by a layer of ordinary pigmented endodermal cells (Pl. III. *St*).

The tentacles of the alimentary zooid of *Sporadopora dichotoma* were the only ones amongst those of all the Stylasteridæ which I was able to observe in the fresh condition, and time did not allow of more than a cursory glance at these even. It sufficed, however, to show that the tentacles are, as in the case of *Millepora*, knobbed at their tips (Pl. X. fig. 4), and that their stems display the usual characteristic transverse segmentation of the endoderm.

The knobs of the tentacles are ovoid in form and are densely beset with nematocysts of the smaller variety. The ectodermal layer of the stems of the tentacles contains few or no nematocysts.

*Gonophores.*—Although the soft parts of at least three different colonies of *Sporadopora dichotoma* were examined, these specimens proved all to be male. In all the specimens gonophores were very abundantly present. They occupy the ampullar chambers in the calcareous cœnosteum already described (Pl. II. fig. 1, G). The male gonophores are ovoid bodies with their long axes directed at right angles to the surface of the coral. Sometimes only one such body is present in an ampulla, sometimes two or three. The outer extremities of the gonophores are sometimes drawn out into a short tail-like prolongation (Pl. III. G). The bodies vary considerably in dimensions. Often a gonophore which is fully mature and just ready to discharge its contents at the summit of its ampulla (as seen in Pl. III. G) has beneath it in the deeper part of the same ampulla an immature gonophore, around which latter the ampulla is less dilated.

The gonophores are composed of a spadix, which is extremely conspicuous in the fresh condition of the tissues, because it is full of red endodermal cells and thus deeply pigmented, and a mass of testis cells or spermatozoa. The spadix is cylindrical in form, with a rounded extremity. It occupies the axis of the deeper region of each gonophore. It thus forms the core of the spheroidal body, the remainder of the mass of which is composed of spermatozoa or the cells from which they are developed in various stages of advancement. These cells and spermatozoa are contained within a fine and transparent but tough membrane which invests the whole body of the testis, being derived from the ectoderm. I believe that a layer of the ectoderm invests the spadix within the testis, but am not certain. I could not determine from which layer the spermatic cells are developed.

The spermatozoa are developed in the same manner as in other Hydroids. In Plate III. G, is figured the usual mass of small spermatic cells in an unripe testis. Above this is a ripe testis which is shown as not cut right through its axis, it being bent over a little from the perpendicular to the surface. Hence the spadix is not seen in the section.

The ripe spermatozoa (Pl. X. fig. 12) have conspicuous heads which are elongate bodies curved into a bow shape. They are compressed and flattened in the plane of the curve, so that though broad and conspicuous when viewed on the flattened sides they appear almost linear when seen on edge. At the extremity of the head where the tail is attached, a small rounded vesicle was observed in all cases to be present.

The bases of the gonophores are continuous with large canals of the cœnosarcal meshwork, the endoderm of the spadix being continuous with that of these canals.

### *Pliobothrus*, Pourtalès.

The genus *Pliobothrus* was formed by Pourtalès (Bull. Mus. Comp. Zool., Cambridge, Mass., No. 7) to include specimens dredged by the United States' Coast Survey off the coast of Florida, in from 100 to 150 fathoms. Pourtalès rightly placed the new genus amongst the Hydroids, but, judging from the structure of the hard parts alone, associated it with *Millepora*. He most kindly placed at my disposal specimens of *Pliobothrus symmetricus* preserved in spirit, and in excellent condition; and these have yielded tolerably complete evidence as to the structure of the soft parts. Moreover, the two small specimens transmitted to me proved to be of opposite sexes. I have observed both sexes only in the case of three other genera of the Stylasteridæ, namely, *Cryptohelia*, *Stylaster*, and *Distichopora*. The structure of the soft parts of *Pliobothrus* proves the coral to belong undoubtedly to the Stylasteridæ. The specimens of *Pliobothrus symmetricus* examined by me were dredged off Florida Reef, in 100 to 300 fathoms.

### Cœnosteum of *Pliobothrus symmetricus*.

The cœnosteum is described and figured by Pourtalès (Deep-Sea Corals, Ill. Cat. Mus. Comp. Zool., Harvard Coll., Cambridge, Mass., 1871, p. 57, pl. iv. figs. 7 and 8). He describes three kinds of pores as existing in the cœnosteum. In reality, there are only two kinds of true pores present, viz., the larger circular-mouthed gastropores and the smaller dactylopores, which open at the summits of short tubular projections from the general surface of the cœnosteum. The third kind is described by Pourtalès as very small linear pores disposed over the whole cœnenchyma, and arranged in rows. These are merely spaces between the trabeculæ of hard tissue forming the cœnenchym of the cœnosteum, and are occupied by canals of the cœnosarcal meshwork in the recent condition of the coral. They do not contain any form of zooid. It is to be noted that in *Pliobothrus tubulatus*, a second species (Pourtalès, *l.c.*, p. 58), the projecting tubules of the tubulated pores are much longer than in the case of *Pliobothrus symmetricus*, and thus form a stepping-stone in the series towards the condition existing in *Errina*. The pores of both kinds in *Pliobothrus* are devoid of styles. The gastropore cavities are tubular in form for a short depth from the surface, and then expand suddenly into a wide basin-shaped chamber, which lodges the similarly formed base of the gastrozooid, and from the margins of which proceed numerous large canals running mostly to the bases of neighbouring dactylopores. They sometimes have one or two tabulæ. The cœnosteum is very coarsely porous, otherwise the finer structure is much as in *Sporadopora*. The ampullæ are, as in *Sporadopora*, buried beneath the surface of the cœnosteum. Pourtalès remarks on them as "occasional round cavities found in the centre of the branch, filled with a yoke-like substance contained in a membrane."

### Soft structure of *Pliobothrus symmetricus* (Pl. VIII. fig. 2).

The cœnosarcal meshwork of *Pliobothrus symmetricus* is very like that of *Sporadopora* in general arrangement, as will be seen by reference to the figure (Pl. VIII. fig. 2). The tubes composing it are however much finer and smaller in diameter, and the components generally of the coral are on a smaller scale.

There is the usual surface layer of ectoderm present, and the nematocysts which occur are of the two forms found in the whole of the Stylasteridæ. The offsets of the cœnenchymal meshwork, which join the sheaths of the gastrozooids, show only a very indefinite trace of the radiate arrangement which is so marked in *Sporadopora*. A trace of the arrangement does, however, exist (Pl. VIII. fig. 2, X X).

The gastrozooids are devoid of tentacles.[1] In the contracted condition they consist

[1] In a specimen of *Pliobothrus tubulatus* preserved in spirit, kindly given to me for examination by Count Pourtalès, I saw what appeared to be very short tentacles, five or six in number, on the margins of the mouths of the gastropores. The specimen was, however, not well hardened, and I am uncertain in the matter.

of an upper cylindrical portion (Pl. VIII. fig. 2, Z), and a wider saucer-shaped basal region, to join the margins of which the lower part of the cylindrical portion gradually widens out inferiorly. Canals are given off from the margin of the basal saucer of the zooid all round, and pass to join the general cœnenchymal meshwork; but no canals at all are given off from the rounded under surface of the zooid. The upper surface of the cylindrical portion of the zooid is nearly flat, and is occupied by the mouth, which is a cruciform slit bounded by elongate gastric endoderm cells, closely similar to those described as existing in *Sporadopora*.

The dactylozooids are simple elongate-conical bodies devoid of mouths, with a minute structure closely similar to that of the corresponding zooids of *Sporadopora*. In the retracted condition they are thrown into a series of transverse folds which are indicated by fine transverse lines in the figure (Pl. VIII. fig. 2, T Z, T Z). The zooids appear to be retracted directly within their sheath, and not to be attached on one side of their base.

The gonophores are contained in ampullæ, which are often sunk deep within the cœnosteum; and it is not apparent by what means the large mature planulæ find their way to the exterior. I have not had sufficient material at command to determine whether the ampullæ, as they enlarge, come gradually to communicate with the surface of the cœnosteum by means of absorption of the intervening hard tissues. It seems probable that they may do so.

The ova are solitary, one only being developed in each growing ampulla. Each ovum is developed within the cup of a cup-shaped spadix (Pl. VIII. fig. 2, O). The ovum is provided with a germinal vesicle and spot. It is covered by a fine layer of ectoderm, which is reflected over it from the surface of the spadix. It is not patent how fertilisation takes place—that is to say, how the spermatozoa find their way to the sometimes deeply-seated ova. As the ovum advances in development and increases in size, the spadix enlarges with it (Pl. VIII. fig. 2, G). Subsequently, however, in later stages, the spadix appears not to increase further; and when in relation with a nearly fully-developed planula appears proportionately small.

The nearly mature planula (Pl. VIII. fig. 2, P) is a large object of an ovoid form, with a long diameter greater than the extreme width of the gastrozooid. Its ectoderm and endoderm are plainly differentiated. The endoderm is composed mainly of oil-cells, but contains also a few fully formed nematocysts of the larger variety. The ectoderm, a thick layer, shows the characteristic striation vertical to the outer surface of the planula, the striæ being composed of granules and nuclei arranged in linear groups. As far as could be ascertained from the scanty material at command, it appeared that the ectodermal layer is formed in development by the process of delamination. No trace of an invagination in the embryo was observed.

In very advanced stages the planulæ become folded to a slight extent, as in the case

of those of *Errina labiata* (Pl. IV.), in order to accommodate their length within the ampullæ.

The male stocks of *Pliobothrus symmetricus* are in every way similar in structure to the female, with the exception that they bear male gonophores instead of female in their smaller ampullæ.

The male gonophores (Pl. VIII. fig. 3) are sacs containing a number of small ovoid bodies which contain spermatozoa or sperm-cells in various stages of development. The exact structure of these smaller bodies, and their relations to the endoderm, were not determined.

### *Errina*, Gray.

The genus *Errina* was formed by Gray to contain the *Millepora aspera* of Linnæus and Esper. Gray gave a short diagnosis of the genus in the Proc. Zool. Soc., 1835, p. 85, from specimens in the British Museum; and this was supplemented by Saville Kent, in a paper published in the same journal for 1871 (p. 282) by further reference to the same specimens. A specimen dredged by H.M.S. Challenger off the mouth of the Rio de la Plata, in 600 fathoms, is clearly referable to this genus, but represents a new species for which the name *Errina labiata* is adopted.

### Cœnosteum of *Errina labiata* (Pl. I. fig. 7).

The cœnosteum occurs in the form of arbuscular multi-ramified masses, which have an extreme height, in the specimens obtained, of about 5 inches. The mass of branches and branchlets has a tendency to form an irregular flabellate expansion, which in the largest specimen obtained has a breadth of about 4 inches. The main stems, which are irregularly oval in section, being flattened in the plane of the flabellate expansion, have a longer diameter of about two-thirds of an inch. They, as well as the remainder of the cœnosteum, are composed of a compact, hard, glistening, white, calcareous tissue. At their bases, this tissue spreads over and encrusts objects to which the coral mass is adherent. In one specimen obtained, the support thus fastened on is a large dead mass of *Sporadopora dichotoma*. The main stems have a surface which appears smooth and even to the naked eye, but when magnified is seen to be scored in all directions by small more or less tortuous canals, which in the recent state contain the superficial ramifications of the cœnosarcal meshwork. In specimens in which certain regions of the main stems are dead and somewhat corroded, these scorings of the surface are much more conspicuous than on the recently living regions, and give the surface a roughly engraved appearance. The finer branches have a tendency to develop mostly on one face only of the flabellate expansion, one face of the main stem being frequently devoid of

such branches. The branches and branchlets are nearly circular in section, and have a hirsute or finely spinous appearance. This appearance is due to their being beset all over their surfaces with small nariform projections, the wide openings of which are all turned towards the tips of the branches. These nariform projections vary much in form, being often drawn out into tubes opening by a slit-like mouth on the side next the tip of the branch, and frequently coalescing, especially towards the tips of the branches, so that two or three of the projections have a common base.

These projections are the prolongations of the walls of the dactylopores beyond the main surface of the cœnosteum. Their cavities, the pores, are simply tubular without any style, and extend for a short distance into the mass of the branch, on which they are situate in an oblique direction, in continuance of the oblique inclination of the nariform projections. The dactylopore projections are very numerous and closely set towards the tips of the branchlets, more widely scattered upon the surfaces of the branches and almost absent on the main stems.

Scattered over the surfaces of the branches and branchlets are the mouths of the gastropores, which are tubular cavities larger than the dactylopores, but with a similar oblique direction towards the axes of the branches, and are provided with a calcareous style, with a finely dentate surface (Pl. IV. S T). The mouths of the gastropores are irregularly circular in outline, their margins being frequently broken and indented by the confluence with the pore cavities of the superficial channels of the surface of the cœnosteum. The gastropores are frequently situate beneath the bases of the dactylopore projections, so as to be covered by these as by a projecting lip; and in places the margins of the gastropores themselves are drawn out into scale-like lips, though these lips are nearly always fused with nariform projections of contiguous dactylopores. Gastropores are frequently to be seen occurring isolated and solitary on the branches.

The ampullæ are, in this genus, conspicuous bodies, since they appear as hemispherical projections from the surfaces of the branches of about the size of a mustard-seed. In vigorous specimens they are closely crowded together in masses on both sides of the branches and branchlets in various regions of the flabellum. The ampullæ commence as small cavities in the surface layer of the cœnosteum of the branches, and gradually enlarging in accordance with the development of the ovum contained in each, project more and more, until those containing mature, or nearly mature, planulæ appear as the conspicuous projections above described. A hemispherical cavity, excavated in the surface of the cœnosteum, corresponds with each ripe ampulla, but the excavation is usually not deep enough to render the entire ampullar cavity spherical in form. The cavity has rather the form of a sphere with one side somewhat flattened. In accordance with the gradual expansion of the ampullar cavity, its outer wall, which is finely reticular in structure, becomes thinner and thinner until, no doubt, it at last

breaks away entirely, allowing the escape of the imprisoned planula. The empty hollows remaining after this process is complete are abundantly present on the surfaces of the branches, and are often to be seen remaining on the older regions of the main stems, although in these older regions there is a tendency to obliteration, by interstitial calcareous deposit, of all pores and ampullæ.

The mass of the cœnosteum is composed, as in other Stylasteridæ, of hard calcareous tissue permeated in all directions by meshworks of canals. The canals generally are, in the present genus, larger in proportion to the size of the zooids than in most other forms (Pl. IV.), and the meshworks formed by them are comparatively widely open. The main canals have a general tendency to traverse the axes of the stems and branches, spreading out at an inclination corresponding with that of the pure cavities towards the surfaces. This arrangement necessarily results from the mode of growth. In the older regions of the stem the cœnosteum becomes more compact and stony by obliteration of many of the canals, but the main canals appear never to become entirely obliterated even very low down towards the bases of the stems.

### Soft structures of *Errina labiata* (Pl. IV.).

*Cœnosarc.*—The cœnosarcal meshwork in *Errina labiata* is more widely open in its structure than in *Sporadopora dichotoma* (Pl. IV.). Hence the mass of soft structures separated from the cœnosteum by decalcification is comparatively soft and less able to maintain the original form of the corallum. In the present species, however, in all the actively living branches it is not, as in *Sporadopora dichotoma*, a mere surface layer of the coral which is living supported by dead cœnosteum below, but the deeper canals of the cœnosarc retain their vitality even to the very axes of the branches. The general arrangement of the cœnosarcal canals is seen in Plate IV. Closer meshworks compose the mass near the surface, and in deeper regions the canals are larger and form wider and longer meshes, and constitute an axial system of main canals by which the various distant zooids are brought into relation with one another. Around the sacs of the gastrozooids an irregular radial arrangement of the canals immediately adjoining the sacs is to be observed, representing the more regular radial disposition described as existing in *Sporadopora dichotoma*.

The histological structure of the cœnosarcal canals is closely similar to that occurring in those of *Sporadopora*. The endodermal pigmented cells are of a light brick-red colour, and hence the entire coral in the recent state is thus coloured. The pigment is, however, soluble in alcohol, and thus quickly extracted in specimens preserved in that fluid, but it is insoluble in glycerine. A continuous superficial layer is present on the surface of the coral, as shown in Plate IV., and it is composed of polygonal nucleated cells (Pl. XI. fig. 10).

*Errina* is the only genus of Stylasteridæ in which the definite cellular structure of the surface layer of the ectoderm could be determined, although no doubt a similar structure exists in that of all the species of the family.

In places the cells composing the layer appear to overlap and sometimes to form a double layer, as seen in the figure. Possibly this appearance is due to the action of reagents.

Nematocysts of two kinds, larger and smaller, occur, and of the usual forms. The larger are mostly gathered into thickly set masses or nematophores (Pl. IV. N N), but occur also scattered, or in twos or threes, within the surface layer (Pl. XI. fig. 10, N). These scattered nematocysts have the appearance of lying within the polygonal cells composing the surface layer (Pl. XI. fig. 10), as is the case in *Hydra viridis*, as shown by F. E. Schulze.[1]

The smaller nematocysts occur scattered in the surface layer (Pl. XLIV. fig. 10, N), and thickly set in the tentacles of the gastrozooids and outer surfaces of the dactylozooids.

*Dactylozooids.*—These are simple elongate mouthless conical bodies, closely similar to those of *Sporadopora*, but somewhat more attenuated in appearance (Pl. XXXVII. D Z). They are attached to the bases of sacs which line the cavities of the nariform dactylopores of the cœnosarc, the walls of which sacs are continuous in structure with the surface layer of ectoderm.

*Gastrozooids.*—These are cylindrical in form (Pl. IV. G Z), with a rounded conical hypostome and four tentacles set in a single whorl at its base. The tentacles are, in the contracted condition, clavate in form. The base of the zooid rests on the style of the containing gastropore, which in the retracted condition of the zooid appears to project into the gastric cavity to a considerable distance as in *Sporadopora*. The ectodermal covering of the gastrozooids is composed of transparent ovoid cells (Pl. XI. fig. 4), which form a layer resting upon a substratum containing numerous nuclei and bounded by the basement membrane. The gastric endodermal lining of the zooids is composed of elongate cells of closely similar nature to those occurring in *Sporadopora*. The mouth appears, when closed, as a crucial slit; four main canals usually lead from the base of the zooid cavity to the cœnosarcal meshwork.

*Growth by Budding.*—Fresh zooids are added to the colony by means of buds arising from the surface layer of the cœnosarc at points where this is joined by offsets of the superficial canals of the cœnosarcal meshwork. Such a bud is represented in Plate IV. D. The part of the superficial layer immediately surrounding the bud is depressed, and forms the sac of the zooid.

*Gonophores.*—Only female examples of *Errina labiata* was obtained for examination.

[1] Über den Bau und die Entwicklung von *Cordylophora lacustris*, Leipzic, W. Engelman, 1871, Taf. vi. fig. 10.

The female gonophores are closely similar in structure to those already described as occurring in *Pliobothrus symmetricus*; but there is this great difference—that whilst in *Pliobothrus* the ampullæ and their contained ova and planulæ remain until maturity immersed in the cœnosteum beneath its surface, in *Errina* the ampullæ project more and more above the surface as development proceeds.

The spadix in *Errina labiata* is at first cup-shaped (Pl. IV. S), the walls of the cup being composed of a very thick layer of endoderm. The cavity of the cup is directed towards the surface of the coral, and within it rests the single large ovum with its distinct germinal vesicle and spot. Each ampulla contains invariably only one spadix and ovum. The ovum is covered over in the cup by a reflection of the ectodermal investment of the spadix (Pl. IX. fig. 4).

The stages of yelk division were not detected. The ovum becomes developed into the condition of a planula within the ampulla. As development proceeds, the embryo becomes gradually greatly increased in size, and assumes a form corresponding to that of the containing ampulla already described. As the process proceeds the spadix becomes divided at its margin into a series of lobes, which lobes subdivide, branch, and unite to form a network, and encroach over the surface of the embryo until more than half of the proximal surface of the embryo becomes thus embraced by the reticulate cup of the spadix (Pl. IV. S').

The ectodermal layer of the embryo seems to be formed from the general mass by delamination. No trace of any process of invagination was observed; but all stages were seen which would appear to prove that the ectoderm layer is gradually differentiated at the surface from the outer elements of the mass. The ectodermal layer when first observable as distinct, appears finely granular in structure, whilst the abundant endodermal mass is composed in large part of highly refracting oil-globules. The ectoderm, as development proceeds, shows a striation directed perpendicularly to the surface of the embryo all over, and this condition is very conspicuously marked in the fully-developed planula (Pl. IV. E C). The mature planula is elongate-ovoid in form, and is slightly folded once upon itself in order to accommodate itself to the confined space within the ampulla. The layer of ectoderm described as investing the surface of the ovum, and derived from the spadix, persists as a covering of the mature planula until set free (Pl. IV. B).

In fine sections of mature planulæ the fine structure of the ectoderm and endoderm is well seen. The ectoderm forms a thick layer composed of alternately placed transparent and opaque tracts disposed vertically to the surface of the planula. The more opaque tracts contain numerous nuclei and thread cells in process of development. The dark tracts fuse together towards the inner region of the layer, and form a continuous mass full of nuclei which rests upon the basement membrane, as yet little differentiated but still clearly indicated (Pl. XI. fig. 9, B).

When the planula is viewed from the surface the transparent areas of the ectoderm are seen to be enclosed by the opaque tracts which spread round them : a condition more clearly marked in the case of the planulæ of *Cryptohelia*.

The endodermal mass of the planula is composed of much granular matter, in which are embedded numerous small transparent cells and nuclei, also oil-globules of various sizes, and many nematocysts in various stages of development (Pl. XI. fig. 9, E N).

## *Spinipora*, Moseley.

Amongst the other Stylasteridæ obtained off the mouth of the La Plata, in 600 fathoms, was a single specimen of a form, to receive which I have made a new genus, *Spinipora*. It is closely allied to *Errina*, but shows sufficient differences in the structure both of the hard and soft tissues to warrant its being placed, at present at least, in a separate genus.

### Cœnosteum of *Spinipora echinata*.

The cœnosteum (Pl. I. fig. 3) is in the form of a single irregularly cylindrical stem, bearing at its summit, in the only specimen procured, a couple of similarly shaped branches. The base of the stem is somewhat swollen, and encrusts the object to which it adheres. The whole surface of the cœnosteum is thickly beset with spinous projections, which, being all inclined towards the tips of the branches, stand out beyond the main surface of the stem to a distance of as much as 1-10th of an inch, the diameter of the stem itself being about 3-10ths of an inch. The spines are spout-like in form, more or less conical, with the ends usually truncated, and their upper surfaces—that is, those turned towards the tips of the branches—channelled out into deep and wide grooves. The grooves usually commence on the surface of the spines as slits, and widen out to terminate at the truncate ends of the spines in wide spout-like mouths. The groove-like excavations are continued as tubular cavities for a short distance into the axes of the spines, beyond the slit-like commencement of the grooves. The grooves are the cavities which are occupied by dactylozooids—are, in fact, the dactylopores, which are here excavated within long projecting spines, and are widely open on one side for nearly their entire length. The small continuation of the groove within the axis of each spine represents the normal dactylopore.

Two kinds of dactylopores occur in the present form : the larger ones already described, and much smaller pores, which are mostly placed on the bases of the spinous processes but occur also more sparingly on the general surface of the stem ;

these smaller pores often have the sides of their mouths slightly raised above the surface which they perforate.

The main surface of the stems and branches of the cœnosteum is grooved by short canals, which are just open to the surface and run short courses, being never much branched and usually crooked (Pl. II. fig. 4). These channels correspond with those described as occurring in *Errina*, and are occupied in the recent condition of the coral by the most superficial reticulations of the cœnosarcal meshwork.

Lying in deep depressions between the bases of the spinous projections are the gastropores, which are deep pits with circular mouths, at the margins of which dactylopores of the smaller kind frequently open. The gastropores are provided with styles, which are very deeply situate and have brush-like tips, and are much like those of *Sporadopora*, but not so elaborately branched. The substance of the cœnosteum of *Spinipora echinata* is hard and compact in structure, and white.

## Soft structures of *Spinipora echinata* (Pl. V.).

*Cœnosarc.*—The cœnosarc consists of the usual reticulation of canals (Pl. V.), offsets of which pass into and ramify within the dactylopore spines as at B, Plate V. There is a well-developed continuous surface layer of ectoderm which invests the spinous processes and entire surface of the coral, and feebly maintains, in decalcified specimens, the form of the cœnosteum. The layer is, as in other genera of the family, continued into the pores of the cœnosteum to form the sacs of the zooids. The nematocysts are closely similar to those of *Errina*.

*Dactylozooids.*—These are of two forms, larger and smaller. The larger dactylozooids are attached by elongate bases along nearly the whole lengths of the bottom of the groove-like dactylopore cavities. The ends of these elongate bases nearest the coral stems assume a cylindrical form, and are continued into the pore-like prolongations of the grooves to become continuous with canals of the cœnosarcal meshwork. In Plate V. two dactylopore spines, B B, are shown as cut open in order to exhibit this arrangement. The pore-like continuations of the dactylopore grooves are lined by continuations of the surface layer representing the zooid sacs. The free parts of the dactylozooids spring from the elongate attached parts not far from the tips of the spines. In the contracted condition they appear as short, stout, bluntly-conical bodies, which are slightly curved and bent inwards towards the coral stem, and at the same time directed towards its upper extremity. Since the larger dactylozooids were all found in the described condition in spirit specimens, it would appear that they are incapable of being retracted to a greater extent. The pores are certainly not deep enough to allow of their entire retraction within them, and the mode of attachment of the bases would

not allow of such retraction. No doubt the zooids, when active and expanded, are long and attenuated, and the long spines on which they are borne are very possibly to be regarded as contrivances for giving them a long reach. A tendency to attachment by the side of the base, within the zooid pore, has been already noticed as occurring in the dactylozooids of *Sporadopora dichotoma*.[1] It is here the normal condition, and much more fully completed. A closely similar method of attachment and retraction of the dactylozooids occurs in all the genera of Stylasteridæ which form regular cyclosystems of zooids.

The smaller dactylozooids are simple bluntly-conical bodies of less than one-third the size of the larger form. They occupy the smaller dactylopores, and are retracted directly within these when at rest (Pl. V. D D).

*Gastrozooids.*—These are cylindrical in form, with a dome-like hypostome and six apparently simple conical tentacles set on in a single whorl. The zooids are, as usual, retracted within sacs lining their pores. The tentacles in the retracted condition of the zooids are doubled together over their hypostomes, with their tips bent inwards and downwards towards them. The zooid bases terminate in four large canals of the cœnosarcal meshwork, and are firmly united to the styles of the pores.

*Gonophores.*—No generative elements were discovered in the single specimen of this coral obtained for examination.

## *Stylaster*, Gray.

The genus *Stylaster*, which gives its name to the family Stylasteridæ, was established by Gray, in 1831, for the reception of *Stylaster roseus*, the old *Madrepora rosea* of Pallas, and *Oculina rosea* of Lamarck, and others. The species, the structure of which is here to be described, was obtained off the mouth of the La Plata. It appears to have been hitherto undescribed.

### Cœnosteum of *Stylaster densicaulis*, n. sp.

The cœnosteum (Pl. I. figs. 5, *a*) is flabellate in form, with a very stout main stem and branches, which make with one another angles of from 25° to 30°. The main stem and larger branches are oval in section, the longer diameter of the ellipse being at right angles to the plane of the flabellum. The stem and branches give off numerous comparatively small and short ramifying branchlets from their lateral margins. Occasionally as an exception a branchlet is given off from one of the faces of the flabellum at right angles to it, thus distorting its fan-like form.

[1] See page 44.

The pores are arranged in regular symmetrical cyclo-systems, a circular group of dactylopores surrounding in each system a single centrally-placed gastropore. The pores of both kinds occur only arranged in these systems in this species.[1] The cyclo-systems so closely simulate in appearance the calicles of ordinary Hexactinian corals, that the genus *Stylaster* and its allies, such as *Allopora* and *Cryptohelia*, have hitherto been placed amongst the Oculinidæ. The cyclo-systems in the present species appear as small cylindrical masses of calcareous matter, which have a somewhat greater diameter at the free extremity than at the base. In the growth of the coral new systems bud off from the sides of the older cylinders, at the tips of the branchlets. The cylinders thus newly formed have their axes at right angles to those of the old systems to which these are attached, but in the same plane with them, which is also that of the entire flabellum. The branchlets of the cœnosteum, already described as given off by the main stem and branches, are composed of zooid systems thus related to one another. In the more recently formed twigs the arrangement described is plainly apparent, and they have thus a zigzag appearance; but in proportion as the branchlets are traced nearer and nearer to the stems from which they spring, this zigzag arrangement becomes more and more obliterated by deposit of cœnenchym, and in the older regions of the cœnosteum, on the sides of the main branches and stem, the mouths only of the zooid systems remain unburied by the swollen dimensions of the support.

No pore systems occur on either of the flabellar faces of the stem or branches. Short branchlets, as well as single pore systems, are evidently swallowed up, to some extent, by the spread of cœnenchym and increase of the dimensions of the stem, and all stages of the process appear at the lateral margins of the stem near its base. But in order to secure an excessive strengthening of the stem, with the least amount of encroachment upon early-formed pore systems, the stem swells to the greater extent in the direction of its surfaces which correspond with the faces of the flabellum and bear no pore systems. Hence, as already described, it becomes oval in section, being flattened in a plane at right angles to that in which the younger branchlets are compressed.

The cyclo-systems are groups of zooid pores as already described, which have a regular symmetrical arrangement, a single gastropore in each system being surrounded by a circlet of dactylopores. The centrally placed gastropore in each system is a wide tubular cavity with a circular transverse section. This pore is much deeper than its surrounding dactylopores, and has at its bottom a short stout style, with a brush-like

[1] In another species of *Stylaster*, *S. granulata*, dredged off Ascension Island, in 420 fathoms, small isolated dactylopores were observed to occur on the surface of the cœnosteum as a rare exception, apart from the pore systems. One such was observed situate on the side of a cylindrical cyclo-system, and two others at the margin of an ampullar prominence. These were very probably occupied, in the recent state of the coral, by small dactylozooids, the rudiments of those which, in an earlier stage of evolution of the Stylasteridæ, overspread the surface of the ancestral form, as in *Sporadopora*.

conical tip (Pl. II. fig. 3, S). Just above the level of the top of the style is a circlet of small rough projections, which stand out from the wall of the gastropore and contract its bore at this point.

Around the mouth of the gastropore is a circlet of from about ten to fourteen dactylopores, arranged symmetrically at equal distances from one another and from the centre of the mouth of the gastropore. The mouths of these pores are elongated towards the axis of the gastropore, so as to open into, and become continuous with, the cavity of this latter pore (Pl. II. D Z, D Z). The openings of the dactylopores are continued down as wide slits, for some distance on the upper part of the wall of the gastropore, so that the pores have, as it were, two mouths placed at right angles to one another and confluent with one another, the one opening to the exterior, the other into the cavity of the gastropore. The cavity of each dactylopore consists of a wide upper chamber in the region of the widely open mouth (Pl. II. T Z, T Z), and a narrow tubular continuation of this, which traverses the cœnosteum in a direction parallel with that of the axis of the gastropore for about half the length of the latter. Against the outer wall of the pore is a small ridge-like excrescence, with an hirsute surface, which is the style of the dactylozooid (Pl. II. fig. 3, S′), and which is described by Pourtalès as "a rudimentary septum in the shape of a hairy fringe" (Pourtalès, *l.c.*, p. 34).

The dactylopores in each cyclo-system are separated from one another by thin plates of calcareous matter which are directed inwards radially towards the axis of the gastropore (Pl. II. fig. 3, P), and which at first sight have all the appearance of the septa of Hexactinian corals, and have hitherto been mistaken for such by observers. They are however, composed each of two thin laminæ of dense calcareous matter, united by somewhat less compact calcareous substance, which is freely perforated by canals for the passage of offsets of the cœnosarcal meshwork. The thin laminæ are merely the juxtaposed walls of the adjacent dactylopores. These radially disposed plates, which may be termed pseudosepta, have their inner edges continued down the wall of the gastropore for a short distance beyond the margins of the mouths of the dactylopores as well-marked vertical ridges, which soon become merged in the general surface in their course (Pl. II. fig. 3).

The cylindrical masses formed by each cyclo-system are sometimes flat, often gently rounded at the top. Their summits are irregularly circular in outline, but have an indented border, the indentations corresponding with the centres of the pseudosepta in position, and representing the intervals between the opposed dactylopore walls, which are here not obliterated by growth of cœnenchym.

The cyclo-systems, when viewed from above in a line looking directly into the mouths of the pores, show, in all essential particulars, the same structure as that which occurs in *Alloporà profunda*, which is represented diagrammatically in Pl. II. fig. 13. The styles of the tentacular zooids, S S, appear as small projections in the interspaces

between the pseudosepta, and were taken by Pourtalès and others for septa of a second order.

The cyclo-systems have been described as circular in outline of summit, because this may be regarded as their normal condition; but very many of them are distorted in various ways. One edge of the summit of the system is frequently elevated above the other, and this elevation is on the side of the same face of the flabellum in all the calicles; whilst the dactylopores, on the opposite margin of the system, are frequently more or less aborted. This condition forms a step towards that occurring in *Cryptohelia*, where all the cyclo-systems have their mouths turned towards one face of the flabellum. The cyclo-systems in the present species are also frequently elongated in a direction in the plane of the flabellum, and in the case of those systems which are placed at the sides of the main branches parallel with the line of extension of these branches.

Besides being permeated completely by fine canals, the cœnenchym of the pore systems is excavated by numerous rather large lacunar cavities, especially near the base of the style and place of origin of an ampulla (Pl. II. fig. 3).

The ampullæ appear, on both faces of the branchlets, as conspicuous rounded prominences, set in groups, and often fused together into large papillated masses. They do not occur on the flabellar faces of the main stem or branches. They present internally a nearly spherical cavity, which communicates freely by openings with the canal systems of the cœnenchym (Pl. II. fig. 3).

## Soft structures of *Stylaster densicaulis* (Pl. VII.).

*Cœnosarc.*—The outer surface of the coral generally, and of the cylindrical cyclo-systems, is invested by a continuous surface layer of cœnosarc (Pl. VII.). This layer dips down to line the dactylopores, and form the small tubulate sacs of the contained zooids, and also is reflected into the wide cavity of the gastropore, the inner lining of which is the greatly expanded sac of the gastrozooid, which zooid, deeply seated at the bottom of the sac, occupies a very small area of its space (Pl. VII. A). Beneath the surface layer the cœnosarcal meshwork forms a fine reticulation of smaller canals, and a similar fine reticulation lies immediately beneath the lining membrane of the gastropore (Pl. VII.). In the walls of the cyclo-systems, between these two finer reticulations, a series of larger canals form an intermediately placed network, in which the branches have a general direction parallel to the axis of the gastropore, and form a direct communication between the basis of the dactylozooids and the large canals which spring from the bases of the gastrozooids. Offsets of this reticulation pass up into the canals in the interior of the pseudosepta. The three reticulations described are intimately connected together by abundant anastomoses. In Plate VII. B B, the interior of a zooid cyclo-system is represented with the sac of the gastropore and superficial lining network removed, in

order to display the connections of the deeper reticulation with the dactylozooid and its general arrangement. The connections of the reticulations with one another are well seen at the cut edges of the bisected zooid systems, as shown in the plate.

A tortuous and complicated mass of large canals springs from the bases of the gastrozooids at their margins, but not from their under surfaces. Some of these large canals turn also immediately after springing from the gastrozooids upwards, through the wall of the zooid system, to join the main network already described as communicating with the dactylozooids. The remainder of the large canals form a tortuous reticulation which passes down through the cœnenchym of the cœnosteum, by the side of the immediately adjoining zooid system, to anastomose with the corresponding reticulation arising from the base of the gastrozooid of this latter. The walls of the ampullæ, as shown in the figure, are traversed by a fine reticulation of the cœnosarcal canals beneath their covering derived from the superficial layer of ectoderm.

Nematophores, composed of nematocysts of the usual larger form, are placed on the pseudosepta, between the dactylozooids (Pl. VII. N N).

*Zooids.*—One form of dactylozooid and one of gastrozooid only are present.

*Dactylozooids.*—These, in the retracted condition, are short cylindrical bodies, with a rounded, blunt-conical, free extremity. They widen out towards their attached extremities, and are united to the sides of the dactylopores which are outermost in the systems, and to their styles, by elongate bases, which are drawn out below into narrow prolongations which join the cœnosarcal meshwork. The zooids are, in fact, attached in an almost precisely similar manner to that in which the dactylozooids of *Spinipora echinata* are fixed within their groove-like pores. The free cylindrical portions of the dactylozooids in the present species are bent upwards, so as to extend in the wide upper cavity of the dactylopore in a direction parallel to that of the axis of the gastropore. They are seen thus projecting in the centrally placed zooid system represented on Plate VII. D Z, showing partly free above the inner margin of the dactylopore sac, partly seen through the transparent sac of the gastrozooid. A curved line, crossing them transversely, marks the point where the sac of the gastrozooid becomes bent over and unites with that of the dactylozooid. The dactylozooid surfaces, as well as those of the tentacles of the gastrozooids, are thickly set with nematocysts of the usual smaller form.

*Gastrozooids.*—These are short and broad cylindrical bodies somewhat contracted in diameter towards the middle of their length. They terminate above in a dome-like hypostome with the mouth opening at its apex, and are provided with a single whorl of light tentacles set on immediately below the hypostome. The tentacles are, in the contracted condition, very short and stout, with swollen, rounded, knob-like extremities, which reach to a height only just exceeding that of the summit of the hypostome. At the margins of their bases the gastrozooids (Pl. VII. G G) are drawn out into a series of large radially-disposed canals which lead directly into the cavities of the zooids, and

the further disposition of which has been already described. The immediate under surface of the gastrozooid is devoid of canal offsets, and is attached to the centrally placed style.

The histological structure of the zooids in the present species of *Stylaster* closely corresponds with that already described as existing in those of *Sporadopora dichotoma*. The gastrozooids in the present form, and their tentacles, are so short that it seems improbable that these zooids are able to emerge from the summit of the gastropore in the expanded condition of the coral. The dactylozooids probably become, when active, long and filiform, and acting as tentacles bend inwards to supply the gastrozooid with food.

*Gonophores.*—Only male specimens of *Stylaster densicaulis* were obtained. Each male ampulla contains two or three ovoid gonophores, which are attached to large offsets of the cœnosarcal meshwork at one end of their longer axes. They have an internal spadix, and in finer structure seem to differ very little from those of *Sporadopora*. They are shown as seen through the transparent walls of the ampullar sacs in Plate VII. G G.

### *Allopora*, Ehrenberg.

To this genus I have referred a coral dredged off the mouth of the La Plata, on account of the very considerable irregularity with which the pore systems grow out from one another. The coral seems to represent a species hitherto undescribed, which I term *Allopora profunda*.

### Cœnosteum of *Allopora profunda*, n. sp.

The cœnosteum (Pl. I. fig. 6, *a*) is composed of a stout stem bearing numerous branches. The branches ramify to some extent in the same plane, so as to form a sort of flabellum; but this flabellum is curved considerably in the direction of its height, and its lateral margins are also bent over sharply towards the same curved face. The main stem has a sinuous course, and the branches are all more or less curved in direction. The stem and branches are oval in transverse section, being flattened in the plane of the flabellum. The cœnosteum is white, and its surface is minutely granular. The pores occur in regular cyclo-systems; when young they project from the terminal branchlets in the form of small cylindrical masses, which are slightly expanded in diameter at the free extremity. These cyclo-systems show a tendency to a regular alternate arrangement, the base of each system abutting on the side of the preceding, and the axes of the systems being inclined to one another at an angle of about 45° in the

general plane of the flabellum. This tendency is, however, to a large extent obscured by irregularities. One face of the flabellum, viz., that rendered convex by the curving of the whole mass, is entirely devoid of cyclo-systems; whilst a considerable number are scattered over the surface of the branches on the concave face. As the branches thicken by growth of cœnenchym, the cylindrical masses of the cyclo-systems become buried, and only their free ends remain in view as the mouths of pore systems on the surfaces of the branches. Even these mouths become partially overgrown in the active regions of the coral, and in the older parts of the stem frequently obliterated. The cyclo-systems consist of a deep gastropore, provided with a style, and surrounded by from twelve to sixteen dactylopores. The dactylopores are provided with a small hirsute style, as in *Stylaster densicaulis*.

A diagrammatic view of a cyclo-system, as seen from above the mouths of the pores, is given in Plate II. fig. 13. The styles are supposed to be brought into view by deep focussing of the lens. The form and arrangement of the pores are almost exactly similar to that already described as occurring in *Stylaster*.

The very small ampullæ are spherical cavities, which are usually entirely sunk beneath the surface, but sometimes near enough to it in situation to raise upon it very small conical elevations, which easily escape notice, and are present only here and there. The ampullæ are present in abundance in the walls of the pore systems and at their bases.

### Soft structure of *Allopora profunda* (Pl. VI.).

*Cœnosarc.*—A surface layer of ectoderm covers the surface of the coral, as in *Stylaster densicaulis*, and is reflected into the pores to form the sacs of the zooids. The cœnosarcal canals form a fine superficial reticulation at the surface of the coral, beneath the surface layer, and spring from a deeper meshwork of larger canals which, as in the *Stylaster* already described, have a mainly longitudinal course within the thickness of the walls of the pore systems, parallel to the axes of the systems, and lead almost directly from the bases of the dactylozooids with which they anastomose to the large canal offsets given off at the periphery of the bases of the gastrozooids. At the inner surface of the gastropore are finer canals springing from this main meshwork, and from these spring a series of offsets which pass in a direction radial to the axis of the gastropore, to abut on and become united with the outer surface of the sac of the gastrozooid.

The radial offsets are disposed irregularly, at unequal distances from one another, and at all heights in the gastropore (Pl. VI. R R). The inner ends of the radial offsets are often enlarged where they abut on the wall of the sac of the gastrozooid, and they are often forked at their outer extremities, where they spring from the cœnosarcal meshwork.

They appear to be homologous with the radial canals already described as occurring in a similar connection in *Sporadopora dichotoma* (Pl. X. fig. 3). In transverse sections of a zooid system, these radial offsets have much the appearance of the mesenteries of an Anthozoan coral cut across, and in some sections they show a certain amount of regularity in disposition at the particular level selected for the cut (Pl. XI. fig. 12).

These radial structures are here termed offsets, and not canals, because, although in some instances they appear to be similar in construction to the ordinary cœnosarcal canals, and usually show similar structure to these at their outer extremities, they usually consist towards their middles and inner extremities of simple bands of transparent fibrous tissue. The exact structure could not be determined, but it seems probable that these radial bands represent radially disposed offsets of the canal meshwork, which have become developed into fibrous organs with an elastic or muscular function, which is brought to bear on the zooid sac. In the case of the radial canals of *Sporadopora dichotoma*, distinct muscular elements were observed as forming part of their structure.

*Dactylozooids.*—The dactylozooids and their sacs in *Allopora profunda* are so closely similar in form and structure to those of *Stylaster densicaulis*, that they need no further description.

*Gastrozooids.*—The sacs of the gastrozooids in the present species differ from those in *Stylaster densicaulis* in being of smaller diameter in proportion to the dimensions of the pore cavities, and in being held in place by means of the radial offsets already described. It is possible that the wall of the sac of the gastrozooid lies nearer to the wall of the gastropore in the recent condition of the coral than is represented to be the case in Plate XXXIX. G Z, and in Plate XI. fig. 12; but all the spirit specimens examined yielded a similar result when decalcified. The sac of the gastrozooid is, as usual, a reflection of the surface layer of the ectoderm. In the contracted condition it forms a long tubular cavity, somewhat narrowed in the region just above the gastrozooid and at the mouth, and dilated towards the centre. At its mouth, the marginal fold of the sac rises in the form of a flattened dome somewhat above the level at which the openings of the sacs of the dactylozooids commence.

The gastrozooids are very deeply seated at the bottoms of their sacs. They are dome-like in form, with expanded bases. A whorl of tentacles, set on at some distance from the summit of the dome, marks the commencement of the large rounded hypostome. The tentacles are twelve in number, and are set on in a single whorl. They are elongate-ovoid in form. From the base of the zooid a series of radially disposed large canals pass outwards to be distributed as in *Stylaster densicaulis*, a certain number of their branches forming a tortuous meshwork, offsets from which pass to join those of the gastrozooid of the adjacent system.

The structure of the zooid cyclo-systems is clearly displayed in Plate XI. fig. 12, which

is, in some respects, somewhat diagrammatic, but is taken from an actual transverse section. The section is taken above the level of the gastrozooid, which hence does not appear. The sac of the gastrozooid is, however, seen in section, together with its radial supports. The dactylozooids seen in section show the three layers of tissue of which they are composed, viz., ectoderm, basement membrane and muscular layer, and endoderm; and sections of their styles are introduced to show the position of these. The two finer reticulations of the cœnosarcal meshwork, inner and outer, are also well seen, with the larger canals in the interval between them, which at this height in the wall of the system are confined to the interspaces between the dactylozooids.

*Gonophores.*—Male examples only were obtained of the present species. The ampullæ are covered by the surface layer of the ectoderm, and the superficial reticulations of the cœnosarcal meshwork. Within, they contain a sac (Pl. VI. G) in which are developed two or three gonophores of an ovoid form, which are attached to offsets of the cœnosarcal canals, and which show the usual elements characteristic of the various stages in the development of spermatozoa in the family, which elements are massed around a spadix, as in *Sporadopora*. The process of development was not closely followed in the present species.

## *Astylus*, Moseley.

I formed the above genus for a Stylasterid with regular cyclo-systems, dredged off the Meangis Islands in 500 fathoms. The coral is, like *Cryptohelia*, devoid of styles in both kinds of zooids, and differs in structure in no important particular from that genus, with the exception that it has no solid lid-like covering overhanging the mouths of the zooid pores. It possesses, however, a curious tongue-like process deeply seated in the calicle, which probably is the homologue of this lid.

### Cœnosteum of *Astylus subviridis*.[1]

The cœnosteum (Pl. I. fig. 4) consists of a short stem, which breaks up into a few primary branches. These, with their slender secondary branches and branchlets, which are very few in number, ramify in the same plane, and form a small flabellum. The stem and branches are circular in transverse section throughout their length, except where distorted by the presence of zooid cyclo-systems upon them. They are composed of a hard and compact pearly-white calcareous tissue, the outer surface of which is marked by a series of conspicuous fine rounded ridges, which, separated by

[1] The Hydroid here named *Astylus subviridis* was referred to in my abstract paper on the Structure of the Stylasteridæ (Proc. Roy. Soc., 1876, p. 95) as "a *Stylaster* resembling *Cryptohelia*."

shallow grooves, follow the directions of the stem and branches with parallel course, each ridge preserving its integrity for a long distance, except on the pore-bearing face of the flabellum, where the ridges are interrupted by the prominent cyclo-systems. The branches are somewhat swollen at the points where cyclo-systems are attached to them. The whole cœnosteum is, as in other Stylasteridæ, permeated by networks of canals. The axes of the branches are traversed by bundles of large main canals, which place the cyclo-systems in relation with one another.

The cyclo-systems are all, with one exception, which is evidently abnormal in the present specimen, placed on one face of the flabellum, with their axes at right angles to its plane. The systems appear as globose bodies, with flattened tops, which are much wider in diameter than the branches on which they rest, and stand out prominent and entirely free from one another, at regular intervals along the course of the branches. The globose appearance of the systems is due to their being each encircled by a broad prominent zone of confluent ampullæ, which zone has a rounded surface rendered somewhat irregular by the occasional prominence of individual ampullæ. Immediately above this zone, the edge of the summit of each system appears as a delicate lamina, which slightly overhangs the outer wall of the system all around (Pl. II. fig. 8). The summits of the systems are circular in outline, with a series of indentions in the marginal lamina, as in *Allopora profunda*, corresponding with the centres of the outer ends of the pseudosepta. A diagrammatic view of a cyclo-system, as viewed from above the mouths of the pores, is given on Plate II. fig. 15.

The arrangement of the pores in the systems is closely similar to that in *Stylaster densicaulis* and *Allopora profunda*. There is a centrally-placed gastropore in each, which is surrounded by a ring of dactylopores with slit-like mouths. The gastropore in the present genus, however, appears in the form of two chambers, an upper and a lower, which communicate with one another by a constricted aperture. The upper chamber (Pl. II. fig. 8, G P) communicates with the exterior superiorly by a short tubular passage, bounded by the inner ends of the pseudosepta. The walls of the chamber are curved, so that, taken in conjunction with its upper prolongation, it is flask-shaped. At the base of the chamber its walls are curved inwards, so as to bound a horse-shoe shaped aperture, which leads to the lower gastropore chamber beneath. The aperture is rendered horse-shoe shaped by the projection from its margin on one side of a tongue-like process of calcareous matter, which is directed horizontally, with a slight upward curve across the aperture, reaching as far as its centre (Pl. II. fig. 8, B ; fig. 15, A).

The tongue-like process is a solid calcareous structure of a bent conical form, with a rounded extremity. It is grooved on its under surface in the direction of its length, and springs from the margin of the wall of the upper chamber of the gastropore, which is thickened in this region by its stout roots. The process always points in

a uniform direction, viz., in that of the length of the branch on which it is situated towards the tip of the branch. It thus has a similar direction to that of the lids of the cyclo-systems in *Cryptohelia pudica*. In this latter genus, a stout process of calcareous matter, prolonged from the support of the lid, forms a prominent ridge on the wall of the upper chamber of the gastropore in a homologous situation (Pl. II. fig. 7). It seems probable, therefore, that this tongue-like process in *Astylus* represents either a rudiment of a lid like that of *Cryptohelia*, which in an ancestral form protected the mouths of the whole of the zooids of each system, but is in *Astylus* withdrawn deep into the central cavity of the system, so as to protect the gastrozooid only; or that the reverse is the case, and that the condition in *Cryptohelia* represents a further development of that seen in commencement in *Astylus*.

The separation of the gastropore into two chambers by a constriction is already foreshadowed in *Stylaster densicaulis*, as has been described, by the circlet of excrescences which there form a prominent zone in the gastropore above the level of the tip of the style (Pl. II. fig. 3, A).

The wall of the upper chamber of the gastropore in *Astylus subviridis* terminates below in a thin margin, and behind the wall a cavity, continuous with that of the lower chamber of the pore, runs up to communicate by offsets with the tubular portion of the dactylopores. This cavity, in the recent condition of the coral, lodges the main upward-directed canal offsets of the gastrozooid.

The lower chamber of the gastropore is a cavity with a rounded bottom, which is excavated within the substance of the branch supporting the pore system. The cavity communicates with the upper chamber by the horse-shoe shaped opening, and with the dactylopores as already described. With adjacent cyclo-systems it communicates by means of the axial canals of the branches. There is no trace of a style at the bottom of the gastropore.

Around the mouth of the gastropores the mouths of the dactylopores appear as elongate slit-like openings, radially directed towards the axis of the systems. The outer peripherally-placed margins of these slits are rounded, whilst internally the slits join the cavity of the gastropore. The pseudosepta intervening between the dactylopores are, in origin, double laminæ, as in *Stylaster densicaulis*, but in the present form appear as thin plates, which have so regular a radial arrangement and so wide an extent that they simulate the septa of Hexactinian corals more closely than do those of any other Stylasterid.

The inner extremities of the summit borders of the pseudosepta by their arrangement form a circular aperture leading to the cavity of the gastropore. There are from eighteen to twenty-one dactylopores in each cyclo-system. The upper wide slit-like chambers of the dactylopores are continued into small short tubular cavities below, as in *Stylaster densicaulis;* but these are entirely devoid of a style. The mouths of

these tubular cavities are set in a circle, at the bottoms of the interspaces between the pseudosepta, at points about equidistant between the inner extremities of the pseudosepta and the outer margins of the chambers which they enclose (Pl. II. fig. 15).

The ampullæ are confined to the zones around the pore systems, and do not occur on the branches. Their cavities are usually kidney-shaped.

### Soft structures of *Astylus subviridis*.

The general arrangement of the soft structures is represented on Plate VIII. fig. 1.

*Cœnosarc.*—The usual surface layer is present, which is continuous with the sacs of the zooids. A fine superficial reticulation of smaller cœnosarcal canals (Pl. VIII. fig. 1, S S) extends over the surfaces of the branches and ampullæ, and coral generally, beneath the surface layer. The axes of the branches are occupied by meshworks of large canals, which lead from one cyclo-system to another, and place the whole of the systems in free communication with one another.

Large canals are given off from the periphery of the gastrozooids. Some of these communicate directly with the axial meshwork of canals, whilst another set passes upwards in the wall of each cyclo-system to join, after a certain small amount of ramification and anastomosis, the basis of the dactylozooid. From the surface of the meshwork of these latter canals which adjoins the dactylopore cavity, a few transverse smaller canals are given off, which pass inwards radially to be attached to the wall of the pore-sac, and represent the more fully-developed "radial offsets," already described as occurring in *Allopora profunda* (Pl. VIII. fig. 1, R).

The ampullar sacs are embedded in a meshwork of offsets of the larger canals, and each of the gonophores is attached to one or more stout canal branches.

Stout offsets of the deeper canal meshwork traverse the interior of the pseudoseptal laminæ, and especially near the summits of the pseudosepta large tortuous branches pass radially outwards between the dactylozooid sacs, and, branching at their outer extremities, join the surface network at the margins of the cyclo-systems (Pl. IX. fig. 2). Just over the outer extremities of each of the pseudosepta, at the margin of the top of each cyclo-system, and in the angles between the outer margins of the dactylopores, are situated ovoid nematophores. A single nematophore is placed in each above-described position. The nematophores are ovoid sacs, closely packed with about three tiers of nematocysts of the larger form, placed with their longer axes parallel to those of the containing sacs (Pl. IX. fig. 2, N).

The endoderm of the soft parts in the present form were observed to have, in the fresh condition, a dusky bluish-green colour, with which the whole cœnosarc and zooids of the recent animal when dredged were seen to be tinged. The pigment is soluble in alcohol, and yields a green solution, which produces a well-marked absorption-

band in the spectrum when examined spectroscopically. The position of this band was, however, unfortunately not determined.

*Dactylozooids.*—The dactylozooids have bases of closely similar form to those of the dactylozooids in *Stylaster densicaulis* and *Allopora profunda*, and are attached in the same manner within their sacs, with the exception that they have no styles. The free portions of the zooids differ, however, from those in the species just mentioned, in that they are in the contracted condition, longer, more slender, and more gently tapered towards the extremities. Moreover, instead of being retracted within their sacs in a vertical position, *i.e.*, one parallel to the length of the sac, they are in the present form placed out of harm's way by being doubled down within the mouth of the sac of the gastrozooid (Pl. VIII. fig. 1, D Z, D Z). They were observed to be thus doubled down between the pseudosepta and within the gastropore in the fresh corals when dredged.

*Gastrozooids.*—The sac of each gastrozooid is narrowed at the horse-shoe shaped opening, already described as leading, in the cœnosteum, from the upper chamber of the gastropore to the lower chamber in which the gastrozooid lies. The sac is reflected over the surface of the tongue-like process, and passing into the lower chamber, becomes attached to the zooid near the margin of its base. The tongue-like process projects in front of the mouth of the zooid, and must prevent the protrusion of the zooid, except in a crooked direction.

The gastrozooid itself is basin-shaped below, with a cylindrical mass above, the bottom of which gradually expands to join the margin of the basin. The cylindrical upper portion has a flat top perforated by the mouth, which is in the form of a crucial slit, and is abutted on by regularly disposed elongate gastric cells of the endoderm. Numerous large canals are given off from the periphery of the lower basin-shaped portion of the zooid, but none from the under surface of the basin. The disposition of these canals has already been described. The gastrozooids are devoid of tentacles.

*Gonophores.*—Only one specimen of the present form was obtained, and it was of the male sex. The male gonophores appear as large rounded lobulated masses resting within the ampular sacs, and springing from stout offsets of the cœnosarcal meshwork, which pass into the sacs to reach them. Usually two tiers of ampullar sacs encircle each cyclo-system, being contained in the zone of ampullæ described in the account of the cœnosteum.

The minute structure of the lobulated masses is shown in Plate X. fig. 10. A membranous sac derived from the ectoderm, and containing abundant nuclei in its tissue (S), lines the ampullar cavity and encloses the generative lobules. One or two large offsets of the canals of the cœnosarcal meshwork penetrate this sac, and with the ends of these the central mass of the generative structures is continuous. This central mass is composed of spherical nucleated cells filled with granules, and closely

similar in appearance to the endoderm cells which line the cœnosarcal canals; and apparently the endodermal lining cells of the canals, from which the mass springs, are continuous with those composing its substance. All over the surface of this central mass of cells, which is invested with a thin layer of ectoderm, small globose sacs arise as buds, and gradually increase in size until they assume the form of the ovoid masses, which, being thickly set over the surface of the central mass, and hiding it from view, give to the active generative mass the lobulated appearance figured in Plate VIII. fig. 1, G.

The young lobules when first formed appear as small rounded sacs with a thin wall of ectoderm, and containing a very few cells apparently derived from the main central mass. These cells become multiplied in number as the sac increases in size with progressive development. The sac as it enlarges becomes gradually pedicellate, and when mature is attached to the central mass by a narrow pedicle of some length. The walls of the pedicle are continuous with the ectodermal wall of the sac, which wall contains well-defined nuclei in its substance. Within the sac of the lobule a second sac, composed of a finer membrane, encloses the mature or developing generative elements. The wall of this inner sac is not prolonged into the cavity of the pedicle, but passing across its commencement shuts off the main cavity of the lobule from this latter.

The cells contained within the young lobule maintain a closely similar appearance to ordinary pigment endoderm cells, until they have become multiplied into a large mass. On further increase they change their structure and appear as spherical, perfectly transparent masses, each of which contains a large nucleus which becomes most intensely stained when treated with carmine. These transparent nucleated cells, which are closely similar in appearance to those figured by Allman from the male gonophores of *Laomedea flexuosa*,[1] multiply further by division, becoming very minute, but retaining the same structure (Pl. X. fig. 10, C).

From each of these minute cells a spermatozoon is developed. The head of the spermatozoon appears to be developed out of the nucleus of the cell, which, as the process proceeds, becomes first attached to the wall of the cell on one side, and is then gradually drawn out in the form of a curved elongate mass along the wall of the cell until it assumes the form of the head of the spermatozoon, being curled round within the cell nearly into a circle. The various stages in development are shown on Plate X. fig. 11.

The mature spermatozoa were not observed in the fresh condition. Their appearance as seen in specimens hardened in alcohol is shown on Plate X. fig. 11, *g*. They form closely felted masses within the ripe lobules, which masses do not entirely fill the cavities of the inner sacs of the lobules.

[1] Allman, Gymnoblastic or Tubularian Hydroids, Ray Soc., 1871, part 1, p. 65, fig. 31*b*.

In the cavities of the pedicles of the more mature lobules a tissue containing a few transparent rounded cells was seen to be present. This may represent a spadix. No rounded spadix such as that occurring in *Allopora* is present in the interior of the lobules. The histological details were preserved with very great completeness in the present form when hardened in spirit and decalcified, so much so that Plate X. fig. 10, might almost have been executed with a camera lucida from a fine section of a gonophore stained with carmine. It is, however, impossible to determine, without close study of fresh material, so difficult a problem as the determination whether the male elements are derived from the ectoderm or endoderm. The apparent development from endoderm cells, in the present instance, may be entirely misleading; the presence of hard skeletons in the Stylasteridæ unfits them for research on such points.

### *Cryptohelia*, M.-Edw. and H.

A deep-sea coral, dredged in many parts of the world by the Challenger, is referable to the above genus, and although the specimens vary a great deal, they seem not distinct from Milne-Edwards' and Haime's species, *Cryptohelia pudica*. The specimens, the anatomy of which is here described, were dredged off the mouth of the La Plata.

### Cœnosteum of *Cryptohelia pudica*.

The cœnosteum is well figured by Milne-Edwards and Haime,[1] and described[2] by these authors as having the form of a small espalier tree, with all the branches comprised in the same vertical plane, and all the calicles turned to the same side (Pl. XII. fig. 7). As far as the form and arrangement of the branches is concerned, the cœnosteum of *Cryptohelia* differs in no important particular from that of *Astylus subviridis* which has just been described. The striæ on the surface of the branches are in the present form finer and run for shorter courses than in *Astylus subviridis*, and well-marked prominent ridges are not formed between them.

Regular cyclo-systems are present in *Cryptohelia*, and are all turned towards one face of the flabellum. Their mouths are not elevated above and isolated from the surfaces of the branches as in *Astylus*, but the branches swell vertically as well as horizontally where cyclo-systems are present, and the cœnenchym of the branch thus rises in a gradual curve to the level of the margin of each cyclo-system (Pl. XXXV. fig. 7).

[1] Milne-Edwards et J. Haime, Ann. des Sci. Nat., 3 ser., t. xiii., pl. iii. fig. 1, 1850.
[2] Hist. Nat. des Coralliaires, Paris, 1857, t. ii. p. 127.

There are from about fifteen to twenty-two dactylopores in each cyclo-system, in form and arrangement almost identical with those of *Astylus subviridis*.

The margin of one side of each cyclo-system is raised up into a stout projection, which is inclined slightly over the mouth of the system for a short distance. After running this inclined course the projection spreads out into a thin broad lamina, with a rounded border, which extends horizontally over the mouth of the cyclo-system, and hangs as a lid or cover over its entire extent (Pl. II. fig. 7, and Pl. XII. fig. 7, *a*, *b*). The inclined portion of the projection is stout and thickened, and is strengthened by being continuous at its base with the adjacent cœnenchym of the branch. It is thickened to the greatest extent in the direction towards the centre of the cyclo-system, and so much so that its substance projects within the cavity of the upper chamber of the gastropore as a prominent ridge. This ridge, becoming gradually less marked as it descends, is continued downwards to the margin of the aperture leading from the upper to the lower chamber of the gastropore, and appears as a prominent thickening of the wall of the upper chamber in this region (Pl. II. fig. 7, A). The dactylopores are aborted and absent in the region of the cyclo-system overgrown by the base of the lid. The lateral margins of this base are often grooved by dactylopores on either side, which have the appearance of having been pushed aside, as it were, by the growth of the projection. The thin horizontal lamina constituting the lid of the cyclo-system is often not quite smooth in surface, but somewhat undulate or crumpled, as it were. The lids are all directed with great regularity towards the tips of the branches on which the cyclo-systems to which they belong rest; the supports of the lids arising from the sides of the cyclo-systems nearest the origins of the branches.

The gastropores are divided into two chambers as in *Astylus*. In the present form the lower chamber is relatively smaller than in *Astylus subviridis*. Its communications with the dactylozooids are closely similar to those in *Astylus* (Pl. II. fig. 7). The opening between the two chambers in *Cryptohelia* is circular, not horse-shoe shaped as in *Astylus*.

Ampullæ occur only in connection with the cyclo-systems in *Cryptohelia pudica*. In the female specimens examined by me, only one ampulla is developed in connection with each system. It may lie on either side of the system, but not on the back of the flabellum. The ampullæ are rounded cavities of irregular form, which, when mature, are so large as to be as wide as the side of a cyclo-system, and occupy it entirely (Pl. XI.).

Numerous specimens of *Cryptohelia pudica*, the soft parts of which are not preserved, have several ampullæ developed in connection with each cyclo-system. These are concluded to be male examples. The ampullæ are not nearly so large as in female specimens, and do not give evidence of their presence by forming swellings on the surface of the corallum.

Soft structures of *Cryptohelia pudica* (Pl. IX.).

*Cœnosarc.*—This differs in structure in no essential particular from that of *Astylus subviridis*. Similar axial canal systems are present in the branches and similar surface networks, but these latter are finer and more complicated in the present form than in *Astylus*. The lid and its support consists of a reflection of the surface layer of ectoderm, beneath which is a prolongation of the surface network of the cœnosarcal canals, and in the thicker portion of the stem of the lid run abundance of prolongations of the deeper and larger vessels (Pl. IX. L). Rounded nematophore sacs, closely similar to those of *Astylus subviridis*, are dotted about over the upper surface of the lid, and, as in *Astylus*, a single one of these bodies is placed at the margins of each cyclo-system over the outer extremity of each pseudoseptum (Pl. IX. N N). The pigmented endoderm cells are coloured brick-red as in *Sporadopora dichotoma*.

*Zooids.*—The zooids of both kinds most closely resemble those of *Astylus subviridis*.

*Dactylozooids.*—These are elongate conical in form, tapering to a point. Their bases are attached as in *Astylus subviridis*. In retraction the part of them nearest the base is doubled back in the wide slit-like chamber of the dactylozooid towards the periphery of the cyclo-system, and then the remainder of the zooid is bent over in the reverse direction and doubled down into the mouth of the gastrozooid (Pl. IX. D Z).

*Gastrozooids.*—These are flask-shaped and closely similar in structure to those of *Astylus subviridis*, being, like it, devoid of tentacles (Pl. XI. fig. 1). The mouth appears at the flat summit of the neck of the flask as a cruciform aperture. The cavity of the zooid is lined with the usual gastric endodermal cells of elongate form, and the layer formed by these cells becomes, as in the gastrozooids of *Sporadopora dichotoma*, thinner as the base of the zooid cavity is approached. There is a thick investing ectoderm layer in the upper part of the zooid, between which and the endoderm layer is a well-marked layer of longitudinal muscular fibres, which fibres are, as in *Sporadopora*, continued for insertion along the main canal offsets of the base of the zooid (Pl. IX. M).

The gastrozooid sac is attached just beneath the origin of the neck of its flask-shaped mass. The main canal offsets spring from the periphery of the rounded base of the zooid, with a radiating disposition (Pl. XI. fig. 1). They curve upwards to be distributed as in *Astylus subviridis*. The calcareous wall of the upper chamber of the gastropore lies in the interval between these canals and the outer surface of the sac of the zooid. No canals spring from the under surface of the zooid.

*Gonophores.*—A fragment of a male specimen of *Cryptohelia*, obtained off the Japanese coast, was examined in a cursory manner, and it was seen that, at first sight at least, it resembled *Astylus subviridis* in the structure of its gonophores. Unfortunately it was mislaid, and I have been unable to find it again.

All other specimens of *Cryptohelia* available for the examination of the soft structures proved to be female only. The ampullæ in *Cryptohelia* are occupied by thin walled sacs. Those in connection with newly-formed cyclo-systems at the tips of the branches of the cœnosteum are small, and contain only a few gonophores in early stages (Pl. IX. G) ; but those attached to older systems are often of enormous relative dimensions, and appear as long reniform bodies (Pl. IX. G), which are almost as large as the masses of the cyclo-systems themselves in volume, and contain gonophores in all stages from the very earliest upwards, and one or two mature planulæ.

The early stages in the development of the ovum of *Cryptohelia* were examined in the fresh condition of the soft parts, without decalcification or use of spirit, the ampullæ being broken open and the gonophores removed from the freshly-dredged coral.

The earliest stage in the formation of a female gonophore observed is the massing together of a small quantity of the endoderm cells of one of the canals of the cœnosarc which enter the gonophore sac (Pl. XI. fig. 3). In the next stage observed, a cup-shaped spadix of endoderm cells is fully formed, the cup being attached to the cœno-sarcal canals by a pedicle. In the hollow of the cup rests a fully-formed ovum, with a well-defined germinal vesicle and spot, its main mass being composed of fine rounded particles. Only a single ovum is developed in relation with each spadix. A thin reflection of the ectodermal investment of the spadix covers the ovum within its cup (Pl. XI. fig. 4, E).

The ova must be in some manner impregnated within the gonophore sac. As development proceeds the ovum increases in size, and the germinal vesicle and spot disappear, and the ovum appears entirely composed of thickly-set oily globules. At the same time the margin of the cup of the spadix, which increases in dimensions in accordance with the ovum, becomes divided into a series of small rounded lobes, about twelve in number, which embrace the lower part of the ovum. The cells composing the spadix and its lobes being coloured dark chocolate, the contained colourless ovum contrasts strongly with its support in appearance in the fresh condition of the structures.

The ovum, as it enlarges, becomes gradually drawn out into an ovoid form (Pl. IX. G). On further development the margin of the growing spadix becomes fringe-like in appearance, the lobes composing it lengthening and becoming forked at their extremities (Pl. IX. S P). The ovum in this stage is much dilated, and drawn out into an elongate ovoid form. Its contents are nearly transparent and highly refractive, but dotted all through their mass with sparsely-scattered oil-globules of various sizes (Pl. IX. O V). The reflection of the ectoderm at this stage still covers the ovum within its cup. A space is enclosed all round the gonophore by this ectodermal membrane, between the margin of the spadix and the ovum. This is filled by a perfectly transparent fluid.

In the next stage observed (Pl. IX. SP′, OV′), the spadix is still further complicated at its margin by subdivision of its lobes, which form a sort of network over one-half of the surface of the ovum, terminating in a fringe of numerous tentacular-like lobes. The ovum is a large ovoid mass, composed of fine rounded particles densely packed together.

In the next stage observed, the developing ovum has already assumed the elongate cylindrical form of a planula (Pl. IX. P1). The stages by which the planula breaks its connection with the spadix were not traced. The earliest planulæ observed appeared to be composed entirely of a uniform mass of fine rounded particles, like those constituting the substance of the latest stage seen in relation with the spadix. The formation of the ectoderm appears to take place by delamination. As the planula develops it becomes much elongated, and an outer layer becomes gradually more and more plainly observable on its surface as distinct from a general mass beneath it (Pl. IX. P2). The early-formed ectoderm layer (Pl. XI. fig. 5) is composed of closely-set, very fine rounded particles; whilst the inner mass, or endoderm, is made up of larger transparent oil-globules. As development proceeds, the ectoderm layer thickens and becomes highly transparent, and being colourless contrasts with the more opaque red-pigmented endoderm within.

The mature planula measures nearly a quarter of an inch in actual length, and is so long that it has to be doubled up in order to allow of its accommodation within the gonophore sac. The planula has a thick, highly transparent, gelatinous-looking ectoderm, and a darkly pigmented endoderm. It is long and worm-like in form (Pl. IX. P3). The surface of the ectoderm is marked out into polygonal areas, which are defined on the surface of the planula at an early period of development (Pl. XI. fig. 6).

A vertical section of the ectoderm of the mature panula (Pl. XI. fig. 7) shows that this thick layer is composed of a transparent gelatinous-looking mass, which is traversed by tracts of small rounded non-transparent elements, which stretch vertically to the surface of the planula, from the surface of the endoderm to that of the ectoderm. These tracts are continued outwards from a layer of similar elements, which rests at the base of the ectoderm, directly upon the surface of the endoderm. The opaque tracts are disposed at roughly regular intervals, and form vertical layers which, rising to the surface of the ectoderm and meeting one another, enclose the polygonal areas already described. In these tracts, apparently out of the opaque elements composing them, numerous thread cells of the larger kind are developed, and are more abundant and thickly set towards the surface of the planula; hence, when the lines enclosing the polygonal areas are viewed from the surface of the planula, they appear mainly composed of rows of nematocysts viewed end on, but partly also of the already described opaque rounded bodies (Pl. XI. fig. 8). Some of the nematocysts contained in the ectoderm of the mature planula were observed to have their contained threads fully developed.

Planulæ were not examined in the fresh condition, hence the ciliation of their surface, doubtless occurring, was not observed. In the most mature planula investigated, the endoderm consisted of pigmented cells, like those of the endoderm of the mature coral, but evidently in a condition of rapid increase, and of oil-globules of various sizes and fine granular matter. The endoderm mass did not show any trace of a central cavity, but appeared homogeneous and solid. The gonophore sacs seem to be permanent in *Cryptohelia pudica*, and the production of planulæ within them to be carried on as a continuous process.

*Growth by Budding.*—In ordinary growth of the coral by budding, every part of the coral surface would appear capable of producing complete cyclo-systems, for in one specimen procured a new cyclo-system has been abnormally produced as a bud from the upper surface of the lid of an older cyclo-system.

## General Remarks on the Structure of the Stylasteridæ.

Summaries of the characteristics of the sub-order Hydrocorallinæ and its subdivisions will be given in the sequel under the heading "Classification." A few further special points in the structure of the family of the Stylasteridæ require to be noted here. The Hydroid affinities of the Stylasteridæ need no discussion; they are borne out by every item of structure.

As in almost all Hydroids, the sexes are on distinct stocks, and these stocks, like those of Sertularians, have a tendency to grow in a flabellate form with alternate gemmation. In having the numbers of the tentacles borne by the gastrozooids regular in number in each species, possibly in each genus, the Stylasteridæ differ from the Milleporidæ, in which the number is variable. The connection of an absence of the styles in the gastropores with a flask-shaped form of gastrozooid devoid of tentacles is remarkable. It occurs in apparently otherwise widely separated genera, *Astylus* and *Pliobothrus*. It is possible that the tentacles of the gastrozooids in all the genera would show traces at least of having knob-like or club-shaped ends were they examined in the fresh condition.

The gonophore sacs within the ampullæ, as containing several distinct gonophores, in several genera at least, seem entitled to the term "gonangia," according to Allman's terminology. It seems uncertain whether the central mass in *Astylus*, from which the sperm-developing lobules are budded off, is to be considered as a blastostyle or not; no definite spadices were observed within these lobules.

The radiate arrangement of the cœnosarcal canals around the sacs of the zooids, which is so remarkably developed in *Sporadopora* and *Allopora*, and traces of which appear in nearly all the genera, is very remarkable. It gives the soft structures of *Allopora*, at first sight, a still closer resemblance in arrangement to that occurring

in *Anthozoans*, than does the very curious simulation which exists in its cœnosteum. The resemblance is, however, in both instances merely superficial, and of no genetic significance.

The branched and fringed processes of endoderm described as embracing the embryos in *Errina* and *Stylaster* appear to correspond with the similarly branched structures in *Cordylophora lacustris*, described and figured by Allman and F. E. Schulze.[1] I have described them as outgrowths of the spadix, but possibly the cup-shaped endodermal structure supporting the ova should not be so designated.

The endoderm of the Stylasteridæ is always coloured, and seems most frequently to assume various shades of red or violet coloration, but in *Astylus subviridis* it is green. The cœnosteum itself is in some species coloured, especially, it would appear, in *Distichopora*, but no doubt in many instances the coloration ascribed to the calcareous structures is in reality due to endoderm dried up within the interstices of the corallum.

In a former paper I conjectured that possibly shallow water Stylasteridæ might bear free gonophores, and perhaps medusiform ones, and that the occlusion of the gonophores within calcareous structures, and their adelocodonic condition, was due to the fact that the forms examined lived in the deep sea. This suggestion was in accordance with the observations of Allman, who has found fixed sporosacs in all deep-sea Hydroids examined by him.[2] I find, however, from specimens sent me by Count de Pourtalès, that ampullæ are especially well developed on the shallow water *Stylaster roseus;* those in the female stocks being very large and prominent. There can, therefore, be little doubt that these structures occur throughout the family.

In all the Stylasteridæ in which the gastropores have styles, the gastrozooids must be protrusible in the expanded condition to a very slight extent. And the fact that in some genera the gastrozooids lose their tentacles seems to bear out this supposition. No doubt in active life the dactylozooids extend like long and filiform tentacles and catch and convey food to the gastrozooid, which nourishes them in return by means of its basal canals and the general circulation. It is to be noted that in those genera in which the gastrozooids have no tentacles, tentacles are wanting in the entire stock.

The nariform and tubular projections of *Errina* are no doubt contrivances for extending the reach of the dactylozooids, whilst at the same time protecting them. In *Acanthopora* the bases of the dactylozooids are pushed out to a remarkable distance from the gastropore mouths, and subsidiary dactylozooids of a smaller kind seem to be necessary to ensure the conveyance of food to the gastrozooid. G. O. Sars, who is the only naturalist who has observed a Stylasterid alive, never saw the zooids raise themselves above the level of the mouths of their cyclo-systems.

[1] F. E. Schulze, Über den Bau und die Entwicklung von *Cordylophora lacustris*, Leipzig, W. Engelmann, 1877, p. 34, plates iii., iv.

[2] Allman, Gymnoblastic or Tubularian Hydroids, vol. ii. p. 155; Nature, Oct. 28, 1875, p. 556.

In the building up of the cœnosteum, which must be deposited, as in *Millepora*, by the ectodermal covering of the cœnosarcal canals, absorption of already formed hard structures must take place during the gradual increase in size of the ampullæ and the widening of canals, which, as shown in the figures, are larger in bore in the deeper than in the younger superficial regions of the cœnosteum. A re-deposit must also take place constantly, for old ampullæ, in the deeper parts of the cœnostea, are to be found in all stages of obliteration. Sometimes in some genera, a rejuvenescence of parts of the cœnosteum takes place; a previously dead area becoming overgrown from its margins by a living lamina, which spreads over and covers it.

### Parasites of the Stylasteridæ.

The cœnostea of nearly all Stylasteridæ are liable to become much distorted in growth by the presence upon them of parasites of various kinds, each of which appears by the special kind of irritation which it offers to produce a particular form of abnormal growth in the part of the cœnosteum it infests, producing thus, as it were, an animal gall. The commonest distortion is the reduction of the stem of a coral or branch, or of one side of these, into a hollow canal or deep furrow, more or less roofed over by a thin wall. This condition is produced by the adherence to the growing stem of an Aphroditacean Annelid. It has been noticed and described by Pourtalès[1] and Verrill, in *Stylaster erubescens* and *Allopora californica*. I have seen it in *Cryptohelia*, *Stylaster*, *Allopora*, and *Errina*. On *Errina labiata*, a parasitic filiform Nemertean also occurs which twines itself round the tips of the branches in many coils. The branches thus irritated grow out into a burr-like mass of projecting points which are evidently hypertrophied dactylopore prominences, and sometimes assume almost the appearance of the normal spines of *Spinipora*.

The most interesting parasite observed was a form found in the gastric cavities of the gastrozooids of *Pliobothrus symmetricus* contained in small capsules. These capsules were badly preserved, but there seemed little doubt that they contained the remains of larvæ of a Pycnogonid, so that the deep-sea Pycnogonids, which are so abundant, very possibly pass through their early stages in deep-sea Stylasteridæ. The formation of a calcareous cœnosteum has not vitiated the capabilities of the Stylasterid Hydroids as hosts for Pycnogonid larvæ. The gastrozooids containing the larvæ were partly aborted.

### Distribution in Space and Time of the Stylasteridæ.

The Stylasteridæ range all over the world, and exist at all depths from shallow water on the coasts to great depths in the open oceans. Two species occur close at

[1] Bull. Mus. Comp. Zool., Harvard, vol. vi. p. 136.

home off the coast of Norway, viz., *Allopora oculina*, obtained by G. O. Sars in from 50 to 100 fathoms, and *Stylaster gemmascens*, which occurs at great depths in the Foldenfjord. The same species, originally described from the Indian Ocean, occurs in the North Atlantic in 530 fathoms. *Stylaster roseus* is abundant in a depth of 2 feet below low water mark on the coast of Cuba,[1] and *Stylaster punctatus* occurs in 9 fathoms off Florida.[2] *Stylaster sanguineus* occurs at Florida and New Zealand, and I dredged a closely allied, if not the same, species in 2 fathoms on the Philippine coast. *Cryptohelia* came originally from New Guinea. It was dredged by the Challenger in all parts of the world, and up to a depth of 1530 fathoms. Some genera, as *Sporadopora* and *Spinipora*, are as yet known only from one locality, but no doubt their range will be extended by further dredging.

No Stylasteridæ are known from geological deposits older than the Tertiary ; indeed, a single species only of one genus, *Distichopora*, had until lately been described as occurring in the fossil condition, viz., *Distichopora antiqua* from Tertiary beds at Chaumont, in France. Fossil Stylasteridæ have, however, been confounded with Bryozoa, just as Gray confounded the recent *Labiopora* with *Porella*. Two species of a genus termed *Dendracis*, figured by Fr. A. Römer,[3] which occur in the Oligocœne of Lattorf, are evidently Stylasterids, and probably members of the genus *Allopora*, in which they have been introduced in the present paper in the list of species, as *Allopora tuberculosa* and *pygmæa*. Some calcareous structures from the *Cenoman* (= middle chalk) figured by the Ritter von Reuss, in the same publication as that containing Römer's paper,[4] and placed with *Heteroporella* as Bryozoa, may very possibly prove allied to *Pliobothrus* on further examination. *Thalamipora*,[5] figured by the same author in the same paper, seems to be a Stylasterid bearing large female ampullæ, present in abundance and agglomerated, the pore systems being all at the ends of the branches, whilst a deep central gastropore in each system is surrounded by a circlet of from five to seven dactylopores. Von Reuss is in great doubt as to the affinities of this form, but concludes that it is a chambered foraminifer. It is probable that now that their importance and structure is more fully known, abundance of fossil Stylasteridæ will be made out. The structure of the Stylasteridæ appears to throw no light upon that of the Graptolites.

[1] Pourtalès, Deep-Sea Corals, p. 83.

[2] *Ibid.*, *l.c.*, p. 36.

[3] Fr. A. Römer, Beschreibung der Norddeutschen tertiaren Polyparien ; Meyer, Palæontographica, Bd. ix. p. 243, taf. xxxix. fig. 15, *a*, *b*, *c*.

[4] Ritter von Reuss, Die Bryozoen des unteren Pläner's ; Palæontographica, Bd. xx., taf. xxxiii.

[5] *Ibid.*, p. 138.

## List of the Species of Stylasteridæ Dredged by H.M.S. Challenger, with Descriptions of New Species obtained and hitherto undescribed.

### *Sporadopora*, Moseley.

*Sporadopora dichotoma*, Moseley.[1]
Dredged on one occasion only, but then in considerable abundance.
Station 320. Off the Mouth of the Rio de la Plata. 600 fathoms.

### *Pliobothrus*, Pourtalès.

*Pliobothrus symmetricus*, Pourtalès.
One specimen only obtained.
Station 23. Off Sombrero Island, Danish West Indies. 450 fathoms.

### *Errina*, Gray.

*Errina labiata*, Moseley.
Several specimens obtained on two occasions.
Station 320. Off the Mouth of the Rio de la Plata. 600 fathoms.
Station 135. Off the Tristan da Cunha group. 90 to 150 fathoms.

### *Distichopora*, Lamarck.

*Distichopora irregularis*, n. sp. (Pl. XII. fig. 8, *a*).

*Distichopora irregularis*, mentioned but not described (Phil. Trans. Roy. Soc., 1878, part 2, p. 502).

Cœnosteum of a light pinkish colour, branching irregularly, flabelliform; branches rounded but moderately flattened in the plane of the flabellum, more compressed towards their tips. Surface of the cœnosteum finely granular in texture. Lines of pores sometimes placed on the flabellar edges of the branches, sometimes absent from these, and coursing irregularly in curved lines over the faces of the branches, often joining one another at various angles. Pore rows consisting of a median row of nearly circular-mouthed gastropores, with very deeply-seated styles, and placed somewhat widely with an interval of about their own width between them; and of a row of elongate-mouthed dactylopores also sparsely disposed on either side. The lines of the pore rows are slightly channelled out in the surface of the cœnosteum.

[1] For references, &c., see the general list of species of Stylasteridæ, p. 83.

Extreme height of the single specimen, 40 mm. Extreme breadth of the branches, 4 mm. In the pore rows about eight gastropores occur in the length of 3 mm.

Off Samboangan, Philippine Islands. 10 fathoms.

### *Spinipora*, Moseley.

*Spinipora echinata*, Moseley.

Dredged once only, when two specimens were obtained.

Station 320. Off the mouth of the Rio de la Plata. 600 fathoms.

### *Allopora*, Ehrenberg.

*Allopora profunda*, Moseley.

Procured once only. Two specimens.

Station 320. Off the mouth of the Rio de la Plata. 600 fathoms.

### *Stylaster*, Gray.

*Stylaster densicaulis*, Moseley.

Two or three specimens.

Station 320. Off the mouth of the Rio de la Plata. 600 fathoms.

*Stylaster duchassaingi*, Pourtalès.

Station 122. Off Point Calvo, Brazil. 400 fathoms.

*Stylaster lævis* (?), Studer.

One dead specimen.

Station 171. Western Pacific Ocean, North of the Kermadec Islands. 650 fathoms.

*Stylaster erubescens* (?), Pourtalès.

One specimen only, possibly blanched by the action of caustic alkali.

Station 170. Off the Kermadec Islands. 520 fathoms.

*Stylaster* (sp. ?). Fragment.

Station 214. Off the Meangis Islands. 500 fathoms.

*Stylaster gracilis*, M.-Edw. and H.

Station 170. Off Raoul Island, Kermadec Islands, lat. 29° 55′ S., long. 178° 14′ W. 520 fathoms. Off Samboangan, Philippine Islands. 30 and 10 fathoms.

*Stenohelia*, Kent (revised by Moseley).

*Stenohelia profunda*, Moseley (Pl. XII. figs. 1–4).

Cœnosteum very delicate, with fine granular surface. Tubular gastropores very long in proportion to the width of their mouths, and extremely deep. From twelve to sixteen dactylopores in each system. Dactylopores very narrow and slit-like. Ampullæ in the angles of the junctions of the branches, often projecting far, and somewhat thorn-like in aspect, having the appearance of being rudimentary branches, converted to several purposes. In some specimens, possibly males, the ampullæ are covered all over with pointed tubercles.

Extreme height of the cœnosteum about 25 mm.

Station 23. Off St Thomas, Danish West Indies. 450 fathoms.

Station 191. Off the Kermadec Islands, lat. 28° 33′ S., long. 197° 50′ W. 600 fathoms.

*Conopora*, Moseley.

*Conopora tenuis*, Moseley (Pl. XII. figs. 5, *a*, *b*, 6).

With character of the genus (p. 97 of the present memoir). Dactylopores in each system from twelve to fifteen in number.

Station 170. Off the Kermadec Islands. 520 fathoms.

*Astylus*, Moseley.

*Astylus subviridis*, Moseley.

One small specimen only.

Station 214. Off the Meangis Islands. 500 fathoms.

*Cryptohelia*, M.-Edw. and H.

*Cryptohelia pudica*, M.-Edw. and H.

A considerable quantity of specimens was obtained from both these localities. The East Indian specimens appear to differ almost constantly from the Atlantic ones in having the margin of their cyclo-systems thin, laminar, and overhanging the exterior. In the Atlantic specimens it is rounded inwards. The East Indian specimens thus seem to possess the peculiarity which Milne-Edwards and Haime elevated into a generic one in their *Endohelia*. I do not refer the forms to separate species in the absence of knowledge of the soft parts of the Eastern form.

Station 3. South of the Canary Islands, lat. 25° 45′ N., long. 20° 12′ W. 1525 fathoms.

Station 24. Off Sombrero, Danish West Indies. 390 fathoms.

Station 171. North of the Kermadec Islands, lat. 28° 33′ S., long. 197° 50′ W. 600 fathoms.

Station 236. Lat. 34° 58′ N., long. 139° 30′ E. Between Vries Island, Oosima, and Cape Sagami, Japan. 775 fathoms.

## Species of Stylasteridæ at present known.

A list of all the species of Stylasteridæ, at present described, here follows. The list is not to be considered as constituting a revision of the species. Access has been had to only a limited number of specimens, and as in the case of many of the species good figures, or indeed any figures at all, are wanting, and the description founded on a false theory as to the nature of the organisms described are necessarily imperfect, a revision has not been found possible. Indeed, such can only be carried out when the soft structures of more species shall have been examined. The list, such as it is, represents an attempt to draw attention to all the species of which an account has been published. Few references are given, those only in each case being selected which are the latest and will supply all further references required when consulted, or those which indicate figures of the species described. The localities are appended in most instances in order to show the distribution of the members of the family.

### *List of all the Species of Stylasteridæ at present known.*[1]

Family Stylasteridæ, Gray (Ann. and Mag. Nat. Hist., vol. xix., 1847).

(I.) Genus *Sporadopora*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 474.
*Polypora*, Moseley, Proc. Roy. Soc., No. 172, 1876, pp. 94, 95.

Species 1. *Sporadopora dichotoma*, Moseley, pl. i. figs. 3, 4; pl. ii. figs. 1, 2, 9.
*Polypora dichotoma*, Moseley, Proc. Roy. Soc., No. 172, 1876, pp. 94, 95, Challenger, Feb. 14, 1876, in lat. 37° 17′ S., long. 53° 52′ W., off the mouth of the Rio de la Plata, from 600 fathoms.

(II.) Genus *Pliobothrus*, Pourtalès, Bull. Mus. Comp. Zool., Harvard, No. 7; Deep-Sea Corals, p. 57. See Ill. Cat. Mus. Comp. Zool., Harvard, No. 10.

[1] In the preparation of the present list I was kindly assisted by Dr F. Brüggemann, of the British Museum.

Species 1. *Pliobothrus symmetricus*, Pourtalès, Bull. Mus. Comp. Zool., No. 7; Deep-Sea Corals, p. 57, pl. iv. figs. 7, 8. Dredged off Florida and Key West, in from 98 to 154 fathoms; lat. 24° 16′ N., long. 82° 13′ W., 229 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 211.

Cold Area of North Atlantic, in 500 to 600 fathoms, P. M. Duncan, Madreporaria of the "Porcupine" Expedition, Trans. Zool. Soc., part 5, vol. viii. p. 336.

Off Sombrero Island, Danish West Indies, in 460 fathoms, Challenger, Proc. Roy. Soc., No. 170, 1876, p. 548.

Species 2. *Pliobothrus tubulatus*, Pourtalès, Deep-Sea Corals, p. 58, pl. iv. fig. 9. Off Havana, in 270 fathoms; lat. 23° 11′ N., long. 82° 23′ W., 292 fathoms, Bull. Mus. Comp. Zool., No. 9, vol. v. p. 211.

(III.) Genus *Errina*, Gray, Proc. Zool. Soc., 1835, p. 35; Saville Kent, Proc. Zool. Soc., 1871, p. 282.

Species 1. *Errina aspera*, Gray, *l.c.* *Millepora aspera*, Esper, Supp. 1, t. xviii.; Lam., vol. ii. p. 202.

Species 2. *Errina carinata*, Pourtalès, Deep-Sea Corals, p. 39, pl. vi. fig. 5. Off Havana, in 270 fathoms; off Havana, 292 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 211.

Species 3. (?) *Errina fissurata*, Gray, Proc. Zool. Soc., 1872, p. 742. Described from a drawing of the living coral. Specimen lost. Affinities doubtful. Dredged in the Antarctic Ocean.

Species 4. *Errina glabra*, Pourtalès. *Lepidopora glabra*, Pourtalès, Deep-Sea Corals, p. 40, pl. vii. figs. 8, 9. Off Havana, in 270 fathoms; off Havana, 100 to 458 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 211.

Species 5. *Errina cochleata*, Pourtalès. *Lepidopora cochleata*, Pourtalès, Deep-Sea Corals, p. 40, pl. iii. figs. 17–19. Off Havana, in 270 fathoms; off Havana, 154 and 292 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 211.

Species 6. *Errina dabneyi*, Pourtalès. *Lepidopora dabneyi*, Pourtalès, Deep-Sea Corals, pp. 40, 41, pl. vii. figs. 10, 11. Fayal, Azores. Depth (?).

Species 7. *Errina labiata*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 443, pl. i. fig. 6. Off the mouth of the Rio de la Plata, 600 fathoms; off the Tristan da Cunha group, 90 to 190 fathoms.

(IV.) Genus *Distichopora*, Lamarck, Hist. des Anim. sans Vert., t. ii. p. 198.

Species 1. *Distichopora violacea*, M.-Edw. and H., Hist. Nat. des Cor., t. iii. p. 451; M.-Edwards, Atlas, Regne Animal, Zoophytes, pl. lxxxv. fig. 4, *a–c*, Island of Timor; Fiji.

Species 2. *Distichopora coccinea*, Gray. Proc. Zool. Soc., 1860. Abundant at the Marshall Group, Pacific Ocean.

Species 3. *Distichopora nitida*, Verrill, Bull. Mus. Comp. Zool. Cambridge, vol. i. p. 46.

Species 4. *Distichopora cervina*, Pourtalès, Deep-Sea Corals, p. 39, *note;* Ill. Cat. Mus. Comp. Zool., Harvard, No. 8, pl. vii. fig. 11, St Thomas, Danish West Indies.

Species 5. *Distichopora foliacea*, Pourtalès, Deep-Sea Corals, p. 38, pl. iv. figs. 12, 13. Off Florida and Key West, 100 to 262 fathoms.

Species 6. *Distichopora sulcata*, Pourtalès, Deep-Sea Corals, p. 38, pl. iv. fig. 14, pl. vii. fig. 7. Off Havana, 270 fathoms; off Cuba. Off Havana, 80 fathoms, Bull. Mus. Comp. Zool., Harvard, vol. v. No. 9, p. 210.

Species 7. *Distichopora barbadensis*, Pourtalès, Ill. Cat. Mus. Comp. Zool., Harvard, No. 8, p. 43, pl. vii. fig. 10.

Species 8. *Distichopora rosea*, Kent, Proc. Zool. Soc., 1871. East coast of Australia.

Species 9. *Distichopora antiqua*, Defrance; M.-Edw. and H., Hist. Nat. des Cor., t. iii. pp. 451, 452. Tertiary fossil at Chaumont and Valmondois.

Species 10. *Distichopora contorta*, Pourtalès, Bull. Mus. Comp Zool., Harvard, No. 9, vol. v. p. 210, pl. i. fig. 9. Off Havana, 175 fathoms.

Species 11. *Distichopora irregularis*, Moseley, present memoir, p. 80, Pl. XII. fig. 8, *a*. Off Samboangan, Philippine Islands, 10 fathoms.

(V.) Genus *Labiopora*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 476.

Species 1. *Labiopora antarctica*, Gray, Pl. II. fig. 5. *Porella antarctica*, Gray, Proc. Zool. Soc., 1872, p. 746, pl. lxiv. fig. 4. Antarctic Ocean. Mistaken by Gray for a Bryozoon allied to *Porella cervicornis*.

(VI.) Genus *Spinipora*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 476.

Species 1. *Spinipora echinata*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 445. Present memoir, Pl. I. fig. 2; Pl. II. fig. 4. Off the mouth of the Rio de la Plata, 600 fathoms.

(VII.) Genus *Allopora*, Ehrenberg, Corall. des roth. Meer., p. 147, 1834.

Species 1. *Allopora oculina*, Ehrenberg, *l.c.* Coast of Norway, 50 to 100 fathoms. G. O. Sars, Fork. Selsk. Chr., 1872, p. 115. Lat. 35° 29′ S., long. 17° 52′ E., 50 fathoms. Studer, Monatsbt, der K. P. Akad. der Wiss., 1878, s. 636.

Species 2. *Allopora miniata*, Pourtalès, Deep-Sea Corals, p. 37, pl. iii. figs. 14–16. Off Florida, 100 to 324 fathoms.

Species 3. *Allopora californica*, Verrill, Proc. Essex Institute, vol. iii. p. 37.

Species 4. *Allopora venusta*, Verrill, Trans. Connect. Acad., vol. i. p. 517.

Species 5. *Allopora nobilis*, Kent, Proc. Zool. Soc., 1871, p. 279, pl. xxv.= *explanata*, Kent, *l.c.*, p. 250, pl. xxv. = *Allopora venusta*, Verrill (?).

Species 6. *Allopora subviolacea*, Kent, Proc. Zool. Soc., 1871, p. 280, pl. xxv.

Species. 7. *Allopora profunda*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 424. Present memoir, Pl. I. fig. 6. Off the mouth of the Rio de la Plata, 600 fathoms.

Species 8. *Allopora pygmæa*, Römer. *Dendracis pygmæa*, Römer, Beschreibung der Norddeutschen tertiaren Polyparien; Meyers, Palæontographica, Bd. iv. p. 243, Taf. xxxix.; Bd. ix., fig. 13, *a–c*. Described as a Bryozoon fossil in Oligocœne of Lattorf.

*Allopora tuberculosa*, Römer. *Dendracis tuberculosa*, Römer, *l.c.*; fossil in Oligocœne of Lattorf.

(VIII.) Genus *Stylaster*, Gray, Zool. Miscell., p. 36, 1831.

Species 1. *Sylaster flabelliformis*, M.-Edwards and Haime, Hist. Nat. des Cor., t. ii. p. 129. Isle of Bourbon, 160 fathoms. Bougainville, Solomon Islands. Studer, Monatsbt. der K. P. Akad. der Wiss., 1878, s. 635.

Species 2. *Stylaster gracilis*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 129. Australia; off Samboangan, Philippine Islands, 30 and 10 fathoms; off the Kermadec Islands, 520 fathoms.

Species 3. *Stylaster roseus*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 130. American Ocean; littoral on the Florida Reefs, 2 feet below low water mark; Pourtalès, Deep-Sea Corals, p. 83. G. Lindström, Actinology of the Atlantic Ocean, K. Sv. Vet. Acad. Hand., Bd. xiv., No. 6, p. 15. On the Josephine Bank, 340 fathoms; off Anguilla, 100 to 150 fathoms.

Species 4. *Stylaster sanguineus*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 130; Ann. des Sci. Nat., t. xiii. p. 96, pl. iii. fig. 2, 1850. Coast of Australia; New Zealand; Florida, shallow water; Pourtalès, Deep-Sea Corals, p. 83.

Species 5. *Stylaster gemmascens*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 131. Indian Ocean; North Atlantic, 530 fathoms, "Porcupine," P. M. Duncan, Trans. Zool. Soc., part 2, vol. viii. p. 332; at great depth in the Foldenfjord, Norway, G. O. Sars, *l.c.*, p. 115.

Species 6. *Stylaster granulosus*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 131; Ann. des Sci. Nat., 3 ser., t. xiii. p. 3, fig. 3, 1850.

Species 7. *Stylaster bella*, Dana, Zooph., p. 696, pl. lx. fig. 6. *Cyclopora bella*, Verrill, Proc. Essex Inst., vol. v. p. 38, 1866. Paumotu Archipelago. (Without style?)

Species 8. *Stylaster amphiheloides*, Kent, Proc. Zool. Soc., 1871, p. 277, with figure.

Species 9. *Stylaster punctatus*, Pourtalès, Deep-Sea Corals, p. 36; Ill. Cat. Mus. Comp. Zool., Harvard, No. 8, pl. vii. figs. 8, 9. Off Florida, 9 to 315 fathoms; off Havana, 80 fathoms; lat. 25° 33′ N., long. 84° 21′ W., 101 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 210.

Species 10. *Stylaster duchassaingi*, Pourtalès, Deep-Sea Corals, p. 35; = *eximius*, Kent, Proc. Zool. Soc., 1871; = *elegans*, Duch. and Mich. (?) Near Tortugas, 43 fathoms. Off Point Calvo, Brazil, 400 fathoms, Challenger.

Species 11. *Stylaster filogranus*, Pourtalès, Deep-Sea Corals, p. 35, pl. v. figs. 13, 14. West Tortugas. Off Havana, Bull. Mus. Comp. Zool., Harvard, vol. v. p. 210, No. 9.

Species 12. *Stylaster asper*, Kent, Proc. Zool. Soc., 1871, p. 278, with figure.

Species 13. *Stylaster erubescens*, Pourtalès, Deep-Sea Corals, p. 34, pl. iv. figs. 10, 11. Off Florida Reef, 120 to 324 fathoms; lat. 25° 33′ N., long. 84° 35′ W. 539 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 210. Off the Kermadec Islands, Challenger, 520 fathoms.

Species 14. *Stylaster rosso-americanus*, Brandt, Z. wiss. Zool., vol. xxii. p. 292. Name given only; no figure or description.

Species 15. *Stylaster tenuis*, Verrill, Bull. Mus. Comp. Zool., Cambridge, vol. i. p. 45. No figure.

Species 16. *Stylaster elegans*, Verrill, Bull. Mus. Comp. Zool., Cambridge, p. 45. No figure.

Species 17. *Stylaster densicaulis*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 449. Present memoir, Pl. I. fig. 5, *a*. Off the mouth of the Rio de la Plata, 600 fathoms.

Species 18. *Stylaster complanatus*, Pourtalès, Deep-Sea Corals, p. 36, pl. ii. figs. 16, 17. *Stenohelia complanata*, Kent, Ann. and Mag. Nat. Hist., Feb. 1870. Off Havana, 270 fathoms; off Havana, from 100 to 458 fathoms, Pourtalès, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 210.

Species 19. *Stylaster virginis*. *Cryptohelia virginis*, Lindström, K. Sv. Vet. Acad. Hand., No. 6, Bd. xiv. p. 15, pl. ii. fig. 24. (The gastropore has a style and the lid is scarcely developed. The specimen can, therefore, hardly be placed in the genus *Cryptohelia* as defined by me. I place it with Stylaster in doubt.) Off Salt Island, Danish West Indies, 200 to 320 fathoms.

Species 20. *Stylaster lævis*, Studer, Monatsbt. der K. P. Acad. der Wiss. zu Berlin, 1877, s. 635, Taf. ii. fig. 5. North of Three King Islands, 90 fathoms. Off the Kermadec Islands; Challenger; 650 fathoms.

Species 21. *Stylaster verrucosus*, Studer, Monatsbt. der K. P. Acad. der Wiss. zu Berlin, 1878, s. 635, Taf. ii. fig. 6. Lat. 35° 21′ S., long. 175° 40′ W., 597 fathoms.

Species 22. *Stylaster obliquus*, Studer, *ibid.*, fig. 7, *a–d.*

Species 23. *Stylaster stellulatus*, C. Stewart, Journ. of the R. Micro. Sci., 1878, with plate. From the neighbourhood of Tahiti. I received a specimen of the same at Tahiti said to have come from the Paumotu Islands.

(IX.) Genus. *Stenohelia*, Kent, Ann. and Mag. Nat. Hist., 1870, vol. v. p. 120, revised by Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 503.

Species 1. *Stenohelia madeirensis*, Kent, Ann. and Mag. Nat. Hist., 1870, vol. v. p. 120, with figure. *Stylaster madeirensis*, Johnston, Proc. Zool. Soc., 1862, Madeira, on a long fishing line. Off the Cape Verde Islands; Challenger. Off Madeira, 50 to 70 fathoms; Studer, Monatsbt. der K. P. Akad. der Wiss., 1878, s. 633.

Species 2. *Stenohelia profunda*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 303. Off St Thomas, Danish West Indies, 450 fathoms; off the Kermadec Islands, 600 fathoms.

(X.) Genus *Conopora*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 503.

Species 1. *Conopora tenuis*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 503, pl. xii. figs. 5, *a*, *b*, 6. Dredged off the Kermadec Islands, in 650 fathoms.

(XI.) Genus *Astylus*, Moseley, Phil. Trans. Roy. Soc., 1878, part 2, p. 477, pl. i. fig. 4.

Species 1. *Astylus subviridis*, Moseley, *ibid.*, p. 457. Present memoir, Pl. II. figs. 8, 15. Off the Meangis Islands, 500 fathoms.

(XII.) Genus *Cryptohelia*, M.-Edw. and H., *l.c.*, p. 127.

Species 1. *Cryptohelia pudica*, M.-Edw. and H. Ann. des Sci. Nat., 3 ser., t. xiii. p. 3, pl. iii. fig. 1, 1850, New Guinea; = *Endohelia japonica*, M.-Edw. and H., Hist. Nat. des Cor., t. ii. p. 128. Japan, present memoir, Pl. II. fig. 7, Pl. XII. fig. 7, *a*, *b*. Atlantic, West Indies, S. Pacific, Japan, 390 to 1530 fathoms; Challenger. Moseley, Proc. Roy. Soc., No. 170, 1876, p. 548. Lat. 35° 21′ S., long. 175° 40′ E., 597 fathoms; lat. 14° 52′ S., long. 175° 32′ W., 905 fathoms, Studer, Monatsbt. der K. P. Akad. der Wiss., 1878, s. 633.

Species 2. *Cryptohelia peircei*, Pourtalès, Deep-Sea Corals, *l.c.*, p. 37, pl. ii. figs. 18, 19; = *Cryptohelia pudica* (?). Off Havana, &c., 270 to 600 fathoms. Lat. 25° 33′ N., long. 84° 35′ W., 539 fathoms, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 211.

## SECTION III.—GENERAL REMARKS ON THE HYDROCORALLINÆ.

### Classification of the Hydrocorallinæ.

I place the Stylasteridæ with the Milleporidæ in a separate sub-order of the Hydroids, which I term Hydrocorallinæ in accordance with a suggestion which I made in my paper On the Structure of *Millepora*, in the Phil. Trans., vol. clxvii. part 1, 1877, p. 132. The placing of the two families together seems justified in the present stage of knowledge concerning them; but the Milleporidæ, in the general form of their zooids, seem allied to the gymnoblastic Hydroids, whereas the presence of distinct gonangia in the Stylasteridæ seems to ally these latter to the calyptoblastic group. Ampullæ seem certainly to be absent in the Milleporidæ, and their gonophores are, therefore, probably developed free of the cœnosteum. Further research may lead to the separation of the two families. The characters of the sub-order Hydrocorallinæ and of the families Milleporidæ and Stylasteridæ are given in the sequel in a concise tabular form, and also in a series of more extended and comprehensive statements in which no known detail of importance is omitted.

The components of the family Stylasteridæ have hitherto been classified from a knowledge of the structure of the cœnosteum alone, and even this has been but imperfectly investigated in most instances; further, the descriptions given of the genera and species have been distorted by the violent efforts made by naturalists to discover septa and interseptal chambers in the so-called calicles of these supposed anthozoan corals.

The descriptions of the genera at least, thus required to be rewritten, and modified according to the present knowledge of the structure of the members of the family. This has been attempted in the sequel, where the characters of the genera given embrace those derived from the structures of the soft tissues as well as of the hard. Unfortunately the soft structures are known in only one species in almost all the genera, and in almost all in but one sex. Hence the classification here given will doubtless need subsequent modification. It merely professes to be an attempt to define the genera in the best manner now possible.

In the case of three genera, *Labiopora*, *Stenohelia*, and *Conopora*, nothing is known of the soft structures.

Count de Pourtalès' genus *Lepidopora* is here emerged in *Errina*, from which it can hardly be considered distinct. The lid-like coverings of the gastropores, by the presence of which the genus *Lepidopora* is distinguished, are most frequently composed of fused dactylopore projections, and do not in most instances consist of special elevations of the margins of the gastropore mouths themselves, although this latter is sometimes the case. *Errina labiata*, a species of which the structure is described in the present treatise, seems to form a gradation between the species described as belonging to

the genus *Lepidopora* and *Errina aspera*. Pourtalès originally placed his *Lepidoporas* under the genus *Errina*.

I have examined the structure of the soft parts of *Lepidopora cochleata* (Pourtalès) in specimens preserved in spirit kindly placed at my disposal by him for the purpose. The specimens were not in very good preservation, but I was able to see that the form very closely resembles *Errina labiata* in the structure both of its cœnosarc and zooids. The dactylozooids are extremely numerous. The gastrozooids have four tentacles. The nematophores are like those of *Errina*. The specimen was a female.

The genus *Stenohelia* (Kent) was originally formed to include *Allopora madeirensis*, which seems to come very near to *Astylus* and *Cryptohelia* in that it has the cyclo-systems all directed towards one face of the flabellum; but the presence of a style in the gastropores is decisive in excluding it from this association, and probably points to the existence in it of a gastrozooid bearing tentacles.

Possibly the name of Verrill's genus *Cyclopora*, founded on the species *Cyclopora bella* [*Stylaster bella* (Dana)] should be substituted for that of *Conopora*, for *Cyclopora bella* appears to be without a style in the gastropore, and *Conopora tenuis* (Moseley) might perhaps be referred naturally to the same genus, but the descriptions in the old terminology are insufficient to determine the point.

The separation of the genera *Allopora* and *Stylaster* is difficult. The different forms of the gastrozooids, and the presence in that of one genus of six, and in that of the other of twelve tentacles, may prove characteristic of the genera. Count Pourtalès sent me specimens of *Stylaster roseus* and *Allopora miniata* in spirit, both species of these genera different from those of which I had determined the anatomy. The soft parts were, unfortunately, badly preserved in the specimens, but the gastrozooids, although their tentacles could not be counted, appeared to correspond in form with those before observed in the other species of the same two genera. A tendency to alternate budding can be made out in all *Alloporas*. It seems probable that the strong tendency to the development of the cyclo-systems on the sides of the branches only in the flabellum will prove a good characteristic for the separation of the *Stylasters* from the *Alloporas*, which would then include all those species in which the faces of the stem and branches were covered with cyclo-systems. The genus *Endohelia* of Milne-Edwards and Haime, as already remarked by Pourtalès[1] and myself,[2] is not in any way separable from *Cryptohelia*. I have examined the type specimen which was sent to me by Dr H. W. Hubrecht from the Leyden Museum for the purpose, and, in the absence of knowledge of the soft structure, should refer it to *Cryptohelia pudica*. Short characters of the several genera of the Stylasteridæ are given in the tabular synopsis immediately following; more extended descriptions follow.

[1] Deep-Sea Corals, *l.c.*, p. 34.

[2] H. N. Moseley, On the True Corals dredged by H.M.S. Challenger, Proc. Roy. Soc., No. 170, 1876, p. 557.

## Tabular Synopsis of the Characters of the Sub-order Hydrocorallinæ, its Families and Genera.

- **Hydroids forming a cœnosteum, with two kinds of zooids, gastrozooids, and dactylozooids.** *Sub-order:* HYDROCORALLINÆ.
  - **Dactylozooids with numerous tentacles. Ampullæ absent.** *Family:* Milleporidæ. — Genus (1.) *Millepora.*
  - **Dactylozooids devoid of tentacles. Gonangia contained in ampullæ.** *Family:* Stylasteridæ.
    - **Pores sporadic, or not in cyclo-systems. Gastropores with styles, except in *Pliobothrus*. Dactylopores without them.**
      - **Dactylopores of one kind only.**
        - Pores of both kinds simple. Gastrozooids with four tentacles — Genus (2.) *Sporadopora.*
        - Dactylopores at the tips of tubular projections. Gastrozooids without tentacles — Genus (3.) *Pliobothrus.*
        - Gastropores sometimes covered with a projecting scale. Dactylopores within nariform projections. Gastrozooids with four tentacles — Genus (4.) *Errina.*
        - Pores simple in a triple linear row at the lateral edges of the branches of the flabellum, rarely on its faces — Genus (5.) *Distichopora.*
      - **Dactylopores of two kinds, larger and smaller.**
        - Larger dactylopores within nariform projections arranged in regular rows. Smaller dactylopores at the sides of these — Genus (6.) *Labiopora.*
        - Larger dactylopores within long spine-like projections. Smaller dactylopores in simple cavities at their bases. Gastrozooids with six tentacles — Genus (7.) *Spinipora.*
    - **Pores occurring in regular cyclo-systems only.**
      - **Styles present in both kinds of pores. Gastrozooids with tentacles.**
        - Cyclo-systems budding from one another somewhat irregularly. Gastrozooids with twelve tentacles (?) — Genus (8.) *Allopora.*
        - Cœnosteum increasing by regular alternate gemmation of the cyclo-systems from one another. Gastrozooids with eight tentacles (?) — Genus (9.) *Stylaster.*
      - **Styles present in the gastropores, absent in the dactylopores. Gastropores very deep, curved towards one face of the flabellum, with one chamber only:** — Genus (10.) *Stenohelia.*
      - **Styles absent entirely. Gastropores with two chambers. Gastrozooids without tentacles (in 12 and 13; in 11 ?)**
        - Cœnosteum irregular not flabelliform. Mouths of the cyclo-systems turned in all directions — Genus (11.) *Conopora.*
        - Cœnosteum flabelliform. Mouths of the cyclo-systems all directed towards one face of the flabellum.
          - Summits of cyclo-systems covered by a lid — Genus (12.) *Cryptohelia.*
          - Cyclo-systems without a lid — Genus (13.) *Astylus.*

## Characters of the sub-order Hydrocorallinæ, and of the Families and Genera contained in it, modified so as to represent the present knowledge on the subject.

### Sub-order Hydrocorallinæ, Moseley.[1]

Compound Hydroid stocks, growing by gemmation. Hydrophyton consisting of a meshwork of ramified cœnosarcal canals, composed of an ectoderm and pigmented endoderm, lodged within channels permeating a hard calcareous support, "cœnosteum," which is deposited by the ectodermal investment of the canals, and forms masses of very various shape. Surface of the Hydrophyton covered with a continuous layer of ectoderm. Zooids of two forms—the one provided with a mouth and gastric cavity, "gastrozooid"; the other mouthless and simply tentacular in function, "dactylozooid." Tentacles, when present, mostly with knobbed extremities. A well-defined muscular layer present in the zooids. Zooids lodged within chambers, "gastropores" and "dactylopores," excavated in the substance of the Hydrophyton, lined by reflections of the surface layer of the ectoderm, forming the "sacs" of the zooids. Zooids of the two forms either scattered irregularly over the surface of the stock, or gathered into groups more or less regular, in each of which a centrally-placed gastrozooid is surrounded by a ring of dactylozooids. Cavities of zooids communicating with the cœnosarcal meshwork by large canal offsets.

### 1. Family Milleporidæ, L. Agassiz.

Cœnosteum irregular in growth, arborescent or encrusting, composed of a thin superficial living layer, supported by a dead mass made up of successive preceding dead layers. Pores devoid of styles, divided into a series of vertically succeeding chambers by transverse calcareous partitions, "tabulæ"; usually scattered irregularly, but in some species grouped with tolerable regularity into systems, in which a centrally-placed gastropore is surrounded by a ring of dactylopores. Nematocysts of two kinds present—the one, the three-spined form, occurring only in Hydroids; the other ovoid in shape, with a thread beset with a spiral of spines. Gastrozooids short, cylindrical, with from four to six tentacles with knob-like tips, set in a single whorl. Dactylozooids long, filiform, and tapering, with an irregular number of short knob-bearing tentacles set on at irregular intervals. Gonophores unknown, but not contained within special cavities in the substance of the cœnosteum "ampullæ."

[1] Prelim. Report, Phil. Trans. Roy. Soc., vol. clxvii., part 1, 1877, p. 132.

1. *Millepora*, Linnæus (Syst. Nat., ed. 10, t. i. p. 790, 1858).
Genus with the characters of the family.

## 2. Family Stylasteridæ, Gray.

Cœnosteum arborescent, with a strong tendency to assume a flabellar form, and to the development of the zooid pores on one face only of the flabellum, or on the lateral margins of the branches composing it. In some genera a superficial layer only of the coral is living; in others, nearly the entire mass retains its vitality. Pores with tabulæ in two genera only. Gastropores usually provided with a conical calcareous projection, "style," at their bases. In some genera a rudimentary style present in the dactylopores. Pores scattered irregularly, or grouped into more or less symmetrical systems, composed of a centrally-placed gastropore surrounded by a circlet of dactylopores. In some genera the mouths of the dactylopores appear as elongated chambers, disposed radially round the centre of the gastropore into which they open, and the chambers being separated from one another only by thin partitions, "pseudosepta"; the systems, "cyclo-systems," simulate closely the calicles of Hexactinian corals. Nematocysts of two kinds, large and small, and of uniform shape in all the genera. Three-spined nematocysts absent. Gastrozooids cylindrical or flask-shaped in form, always entirely retracted within the gastropores when at rest; those of the former shape with from four to twelve tentacles, set in one whorl, and regular in number in all the gastrozooids in each species; those of the latter devoid of tentacles. Dactylozooids simple elongate-conical bodies, devoid of tentacles, sometimes capable of entire retraction within the pores, sometimes not. Stocks of distinct sexes. Gonophores adelocodonic, developed within sacs, "gonangia," which are contained within special cavities in the substance of the cœnosteum, "ampullæ." Stocks of the two sexes alike in form as far as known, except in the size of the ampullæ, which are larger and more prominent in the females. Ampullæ containing in male stocks several gonophores; in female, in some genera, a single gonophore, in others several. Spadix, in the female gonophores, cup-shaped, embracing a single ovum only, which becomes developed into a planula within the gonangium.

1. *Sporadopora*, Moseley (Phil. Trans. Roy. Soc., 1878, part 2, p. 474) = *Polypora*, Moseley (Proc. Roy. Soc., No. 172, 1876, pp. 94, 95).

Cœnosteum pure white, composed of finely reticular but compact cœnenchym, forming stout vertical stems, usually compressed from before backwards, so as to be oval in transverse section. Stem giving off a limited number of irregularly dichotomous branches, which are flattened like it, and tend to coalesce by their lateral margins and assume a flabellate form, which is sometimes somewhat curved. Surface of the cœnosteum

smooth and nearly even. Pores of both kinds with simple circular mouths, irregularly scattered. Gastropores larger, less numerous, with a deeply-seated brush-like style, and very thin and delicate tabulæ placed at irregular intervals. Dactylopores devoid of a style. Ampullæ, in male stocks, ovoid, entirely immersed beneath the surface of the cœnosteum. Pores and ampullæ more abundant on one face of the flabellum than on the other. Gastrozooids cylindrical, with four club-shaped tentacles, dividing at their bases into four main canals. Dactylozooids of various sizes, retracted entirely within the pores when at rest. Gonophores, in male stocks ovoid, with a club-shaped spadix; one, two, or three present in each gonangium, attached directly to offsets of the cœnosarcal canals. Female stocks unknown.

2. *Pliobothrus*, Pourtalès.

Cœnosteum branching, with a tendency to form a flabellum. Surface smooth, marked with small linear openings, arranged in rows, which in the recent state contain branches of the superficial cœnosarcal meshwork. Inner parts of the cœnosteum very coarsely porous. Pores irregularly scattered. Gastropores circular-mouthed, their cavity tubular above, but expanding below into a basin-shaped chamber, without a style, often with one or two tabulæ. Dactylopores showing as minute openings at the tips of small tubular projections, devoid of styles. Ampullæ rounded cavities; in the female very large, in the male smaller; placed deeply, often in the axis of the cœnosteum. Gastrozooids flask-shaped, devoid of tentacles,[1] communicating with the cœnosarcal meshwork by numerous offsets arising all around their bases. Dactylozooids entirely retracted when at rest. In the female a single gonophore in each gonangium; in the male, a group of gonophores (?) in each ampulla.

3. *Errina*, Gray.

Cœnosteum branching, with a tendency to form an irregular flabellate expansion. Pores most abundant at the tips of the branches; irregularly scattered. Dactylopores with delicate nariform or scale-like projections, which vary much in form, being sometimes drawn out into tubes opening on one side by a slit as the pore mouth, but often coalescing, so that two or three projections have a common base and form large scales perforated by the pores; devoid of styles; scales all with a tendency to incline towards the tips of the branches. Gastropores with irregularly circular mouths, often seated in depressions; with a deeply-seated style. The mouths of the gastropores frequently covered by the dactylopore projections inclined more or less over them. Sometimes the margin of the gastropore itself is raised up on one side into a scale inclined over the pore mouth, but this is usually fused with neighbouring dactylopore projections. Ampullæ on both sides of the flabellum, prominent in the female; immersed in the

[1] See note on p. 48.

cœnosteum in the male (?) Gastrozooids cylindrical, with four club-shaped tentacles and four basal canals. Dactylozooids entirely retracted. Gonophores in the female solitary in the gonangia. The free margin of the cup-shaped spadix becomes converted into a ramified fringe, embracing the embryo as development proceeds. Planula as in *Pliobothrus*. Structure of male stocks unknown.

4. *Distichopora*, Lamarck.

Cœnosteum branching flabelliform, with branches usually flattened in the plane of the flabellum; composed of very compact cœnenchym. Pores in most species confined to narrow lines or rows running along the exact centres or edges of the sides of the branches, usually absent on their faces, except as occasional abnormalities or rudimentary branchlets budding in a direction out of the plane of the flabellum. The lines of pores composed of three rows, a central row of larger gastropores with circular or oval mouths; and a row on each side of this of smaller dactylopores, sometimes very minute, sometimes prominent and tubular, often slit-like in aperture, the length of the slit being directed at right angles to the line of the row. Pores very deep, prolonged in curved lines side by side in the plane of the flabellum, inwards and downwards towards the bases of the branches; forming thus throughout the flabellum a thin continuous tract of fragile tubulate tissue, in which the successively-developed curved pore-tubes stand out fanwise, separating from one another the compact masses of cœnenchym forming the opposite faces of the branches. The branches may, therefore, be readily split into two halves along this tubular tract. Older gastropores with immensely long filiform styles; those in the younger gastropores much shorter. Dactylopores devoid of styles. Ampullæ sometimes on one, sometimes on both faces of the flabellum, prominent in the females and often forming confluent masses; sunk beneath the surface of the cœnosteum in the males and invisible exteriorly. Soft structures closely like those of *Errina*. Dactylozooids with very long retractor muscular slips; gastropores with four clavate tentacles. Gonangia as in *Errina* in the females; in the males, containing four or five ovoid masses of spermatozoa.[1]

5. *Labiopora*, Moseley[2] (Pl. II. fig. 5).

(Type specimen in British Museum; mistaken by Gray for a Bryozoon, and described by him as *Porella antarctica*), (Proc. Zool. Soc., 1872, p. 746, pl. lxiv. fig. 4).—Cœnosteum minutely reticulate in texture, composed of a few rounded branches with tapering extremities. The entire surface covered with nariform projections, with elongate cavities, which are arranged in rows along the lengths of the branches, often disposed with great regularity for long stretches. The projections of very uniform shape, and rising from the

[1] Some specimens dredged off the Tristan da Cunha group are probably males, having the ampullæ small, and buried in the substance of the cœnosteum.

[2] Prelim. Report, Phil. Trans. Roy. Soc., 1878, part 2, p. 476.

branches to a uniform height. All inclined in the directions of the tips of the branches. The elongate cavities, which are extended in the direction of the lengths of the branches, have a defined rounded margin at their ends, situated towards the tips of the branches, but gradually merge at their opposite extremities into the deep and complex hollows by which the surface of the coral is excavated, and which are made up of the confluences of cavities of adjacent nariform projections with the other irregularities of the surface. Dactylopores devoid of styles; two kinds present, larger and smaller. The nariform projections are the outgrown margins of the larger dactylopores, which are continued into the substance of the cœnosteum from the cavities of the projections as tubular slits. The smaller dactylopores have mouths of the same general form as those of the larger ones, but with their longer diameters directed at right angles to these latter. They have their walls fused with those of the nariform projections, or often appear as if excavated in the sides of these. They are of one-third or one-fourth the dimensions of the larger pores. Mouths of the gastropores deeply seated in depressions at the bases of the nariform projections. Circular in outline. Gastropores provided with deeply-seated styles with brush-like tips. No ampullæ in the unique specimen. Soft structures unknown.

6. *Spinipora*, Moseley.[1]

Cœnosteum branching. Branches rounded. Entire surface thickly beset with long spinous projections inclined towards the tips of the branches. Spines conical, grooved deeply on their sides turned towards the tips of the branches, so as to present spout-like openings, which are the mouths of the larger dactylopores. Dactylopores of a smaller kind also present; their mouths appear as minute oval apertures scattered over the bases and sides of the spines. Styles absent in the dactylopores. Gastropores deeply seated in hollows between the bases of the spines, having deeply placed styles. Ampullæ absent in the unique specimen. Dactylozooids of two kinds, the larger attached by elongate bases within the spout-like cavities of the larger dactylopores, incapable of retraction within the pores; the smaller minute, entirely retracted when at rest. Gastrozooids cylindrical, with six tentacles and four basal canals. Gonophores unknown.

7. *Allopora*, Ehrenberg.

Cœnosteum branching, but frequently not so as to form a flabellum. Pores in regular cyclo-systems only, excepting in *Allopora nobilis*, where some of the systems are not perfected. Tendency to alternate gemmation present, but weak, and usually obscured by an abundant growth of cœnenchym. Cyclo-systems always scattered over the faces of the branches, as well as situate at their lateral margins; often entirely sporadic in disposition. Dactylopores with a more or less rudimentary style

[1] Prelim. Report, Phil. Trans. Roy. Soc., 1878, part 2, p. 476.

affixed to those parts of their walls which are outermost in the systems. Gastropores, simple tubular, with a brush-like style. Ampullæ sometimes prominent, sometimes scarcely showing at the surface. Dactylozooids attached by elongate bases to the sides of their pores occupied by the styles; partly retracted within the pores, partly bent upwards when at rest within the wide pore mouths. Gastrozooids dome-like in shape, with twelve tentacles and numerous basal canals. Gonangia in male stocks containing two or three ovoid gonophores with club-shaped spadices. Structure of gonophores of female stocks unknown.

8. *Stylaster*, Gray.

Cœnosteum arborescent, usually flabelliform. Pores in regular cyclo-systems only. A strong tendency to the development of these cyclo-systems on the lateral margins of the branches only. Cyclo-systems arising from one another by alternate gemmation. Dactylopores and zooids as in *Allopora*. Ampullæ usually prominent on both faces of the flabellum. Gastrozooids cylindrical, with numerous basal canals and eight tentacles. Gonophores of male stocks as in *Allopora*. Female stocks with prominent rounded ampullæ (*Stylaster roseus*).

9. *Stenohelia*, Saville Kent (Ann. and Mag. Nat. Hist., 1870, vol. v. p. 120).

Cœnosteum delicate, branching, flabelliform; pores in regular cyclo-systems only. Cyclo-systems all turned towards one face of the flabellum. Dactylopores without a style or with a very rudimentary one. Gastropores very deep and curved, so as to tubulate in all but the older branches the entire lengths of the axes of the branches, with small styles seated at the bottoms of these tubes and directed parallel to the axes of the branches at right angles to those of the mouths of the cyclo-systems.

10. *Conopora*, Moseley.[1]

Cœnosteum delicate; with pores in regular cyclo-systems; branching irregularly, the cyclo-systems having their mouths turned in all directions. Cyclo-system masses conical in form. Both kinds of pores devoid of a style. Gastropore with two chambers, the upper opening into the lower by a circular aperture. Differs from *Cryptohelia* and *Astylus* in having no lid or tongue-like process and in not forming a regular flabellum.

11. *Astylus*, Moseley.[2]

Cœnosteum forming a small and delicate flabellum. Pores in regular cyclo-systems, all placed on one face of the flabellum. Cyclo-systems forming cylindrical masses prominent from the branches, and with their axes directed at right angles to the plane of the flabellum. Style absent in both kinds of pores. Gastro-

[1] Prelim. Report, Phil. Trans. Roy. Soc., 1878, part 2., p. 503.

[2] *Ibid.*, p. 477.

pores divided into two chambers, an upper and a lower, by a constriction of their walls. Opening between the chambers rendered horse-shoe shaped by the projection across it, in the direction of the tips of the branches, from that side of its margin placed nearest the base of the branches, of a tongue-like excrescence. Ampullæ in the male stocks in a ring around the cyclo-system masses ; none scattered on the branches. Dactylozooids, when at rest, doubled down within the upper chambers of the gastropores. Gastrozooids flask-shaped, devoid of tentacles, with numerous basal canals. Gonangia in the male stocks containing a central mass of cells from the surface of which are developed as buds numerous pedicellate lobular sacs, in which the spermatozoa are produced. Female stocks unknown.

12. *Cryptohelia*, Milne-Edwards and Haime.

Cœnosteum closely resembling that of *Astylus* in all respects, excepting that the cyclo-system masses are not so prominent, that the opening between the upper and lower chambers of the gastropores is circular in outline, and that a lid-like lamina of calcareous matter is directed horizontally across the mouths of all the cyclo-systems. The lids are supported on stout columns arising from the margins of the cyclo-systems and inclined over them. They spring from the sides of the systems nearest the bases of the branches, and are directed towards the tips of the branches. In female stocks only a single ampulla and gonangium developed in relation with each cyclo-system. No ampullæ on the connecting branches. In the males several ampullæ in the walls of each cyclo-system. Soft structures as in *Astylus*. In female stocks numerous gonophores present in each gonangium in all stages of development. Spadix cup-shaped, developing, as in *Errina*, into a fringed network at the margin. A solitary ovum developed in relation with each spadix. Planula very long and worm-like.

## Pedigree of the Hydrocorallinæ.

The line of descent of the various genera of the Stylasteridæ from a parent form seems to be traceable with especial clearness. All gradations are present by which simple circular mouthed pores sporadically scattered over the cœnosteum become grouped and modified into cyclo-systems of the most symmetrical and complex character. Since styles appear in some genera in the dactylopores as well as in the gastropores, it seems probable that in the ancestral form or "Archistylaster" styles were present in both forms of pore. If the Milleporidæ prove closely related to the Stylasteridæ when their gonophores have been investigated, it will follow that the two families have had a common ancestor, and that Hydroids have developed a calcareous support only once in their history and not in two separate instances. This common ancestor may be presumed to have had a hydrosoma composed as throughout the sub-order Hydrocorallinæ ; with its

pores sporadic, with tabulæ and without styles, and with two kinds of zooids, with knob-bearing tentacles; with a tendency also in the dactylozooids to form ring-like groups around a gastrozooid. This form may be termed "Archihydrocorallina."

Archihydrocorallina was probably derived from a form in which all the zooids composing the stock were provided with mouths and generative organs. In such stocks further development may be conceived of as having arisen by either of two processes. All the zooids may have become gradually modified, so that each performed only one function, and thus had certain of its structures aborted to fit it for this special end. If such be the history of the development of the Hydrocorallinæ, then the gastrozooids, dactylozooids, and generative zooids are to be looked on, as they have been regarded throughout the present memoir, as zooids which have become more or less rudimentary by disease. Or, on the other hand, the view may be taken that the gastrozooids alone represent the original zooids of the ancestral stocks. They remain, having lost their generative organs, and, to a greater or less extent, their prehensile ones, because additional zooids have been formed by budding in order to provide for the wants of the colony in these particulars. On this view the generative zooids and dactylozooids were originally budded out in the condition in which they now exist, or in one not so complete as it is at present, nor so perfectly adapted to their present functions. On this view they have lost no structure by disuse, but have rather advanced in complexity with development, but only in their own special direction.

The former view of the antecedent history of the sub-order Hydrocorallinæ seems to me to be most worthy of acceptation, because the presence of several structures which occur as rudiments in connection with the dactylozooids and generative zooids, but which are fully developed in connection with the gastrozooids, seems to bear out this conclusion. As examples, may be cited the tentacles of the dactylozooids of the Milleporidæ and the styles of the dactylozooids of certain Stylasteridæ. The Stylasteridæ in the complexity of their compound stocks form an interesting parallel to the Siphonophora. In the Siphonophora the several components of the compound organisms are by the best authorities regarded not as individual degenerate zooids, but as buds which tend to assume more and more the form of individuals. The diverse elements composing the organism in the case of the Siphonophora may seem closely paralleled by those of which a Stylasterid is made up, and yet the past history of the two organisms may be very different. In the one case, an ancestral already compound organism may have gradually modified its similar zooids to subserve division of labour; whilst, in the other, a simple ancestor may have gradually developed a similar compound organism by throwing out buds of various forms which have come more or less to approach itself in complexity.

From Archihydrocorallina, Archistylaster was developed with a branching cœnosteum; with a strong tendency to assume a flabellate form, and to develop its pores only on one face of the flabellum, and at the sides only of the branches; with its pores sporadic and

tabulate, and styles in both forms of them. The dactylozooids of Archistylaster were devoid of the knobbed tentacles, these were, however, retained by the gastrozooid. The gonangia were included in hollows in the cœnosteum.

In *Sporadopora*, the most ancestral *Stylasterid* at present known, the styles of the dactylopores have disappeared, and they only reappear apparently by reversion in *Allopora* and *Stylaster*. Rudimentary tabulæ are present in *Sporadopora* and *Pliobothrus*, but disappear in succeeding genera. In *Pliobothrus* the margins of the dactylopore mouths are raised up and prolonged into small tubuli, and the genus would thus lead to *Errina*, where the tubuli become nariform, were it not that in *Pliobothrus* the style of the gastrozooid is lost, and that the gastrozooid is devoid of tentacles and flask-shaped: a condition occurring again only in the most highly specialised members of the family *Astylus* and *Cryptohelia*. *Distichopora* appears to have been derived directly from some form allied to *Errina*.

Two separate modifications of the nariform projections of *Errina* are presented by *Porella* and *Spinipora*, in both which genera further complication ensues by the differentiation of two kinds of dactylozooids.

The process of the formation of cyclo-systems is seen in all stages in different parts of the surface of the single species *Allopora subviolacea*, as will be seen by reference to Saville Kent's figures,[1] or to the diagrams given on Plate I. of the present Memoir, figs. 10, 11, and 12. In this coral five or six dactylopores are grouped in a circle around a single centrally-placed gastropore. In some groups all the pores are simply circular (fig. 10). In others, shallow grooves, often only just indicated, lead radially from the dactylopores towards the gastropore. In others, these grooves are well marked and deep, and a complete cyclo-system is formed. It appears probable that this condition has been brought about by the continual bending inwards of the dactylopores to convey food to the gastropore. The grooves have been the result of the attempts of these zooids to reach the gastrozooid when further and further retracted. Thus, in most *Alloporas* and all *Stylasters*, all the pores have come to form regular cyclo-systems, in which the mouths of the dactylopores are drawn out into elongate chambers, and their tubular prolongations reduced to mere rudiments in many cases. At a very short distance below the surface in *Allopora subviolacea* the pores are found to be in all the systems still entirely independent (fig. 12), and this condition is maintained at greater depths in all *Stylasters*. It is to be noted that in becoming so remarkably modified into elongate slit-like cavities, the dactylopores of Stylasteridæ with cyclo-systems follow an ancestral tendency to modification, for these elongate pores are, taken separately, closely similar in form to the nariform dactylopores of *Errina* and its allies: they only have the lips of all the projections directed radially outwards.

[1] Proc. Zool. Soc., 1871, pl. xxv. fig. 2 *a*.

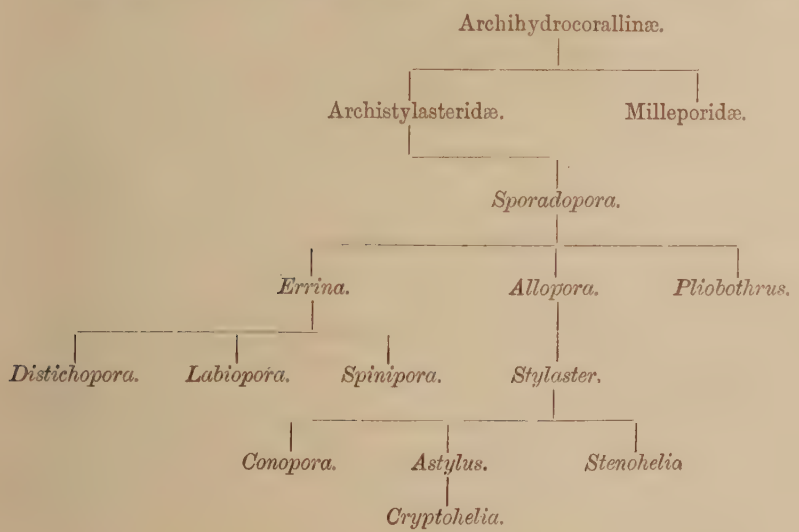
*Stenohelia* appears to form a transition in some respects between *Stylaster* and *Astylus* and *Cryptohelia*. In it, as in the latter, all the cyclo-systems are turned towards one face of the flabellum, and the styles are almost or entirely wanting in the dactylopores; its deep tubular curved gastropores, with their minute deeply-seated styles are, however, very peculiar, and characteristic of the genus.

In *Astylus* and *Cryptohelia* the dactylozooids have come to place themselves out of harm's way, not by retraction within their pores, but by being doubled down within the gastropore, which is divided in two chambers. They are thus enabled to maintain a greater length than they could were they obliged to be retracted within their own pores, and they thus obtain a longer reach.

The lid of *Cryptohelia* may be a further modification of the tongue-like process in the gastropore of *Astylus*, or the reverse may be the case, the structure in *Astylus* being a reduction of that in *Cryptohelia*. If the former view be correct, then the tongue-like process represents the scale often present in *Errina* as a covering of the gastropore, and the lid of *Cryptohelia* is a further modification of this, which is increased in dimensions and altered so as to cover an entire cyclo-system.

*Conopora* forms a gradation to *Astylus* and *Cryptohelia* in being devoid of styles and in having two chambers to the gastropore, but differs from them in its irregular branching and the absence in it of a lid or tongue-shaped process in the gastropore.

The phylum of the Hydrocorallinæ may, therefore, be represented as follows :—



# PART II.—ON HELIOPORIDÆ AND THEIR ALLIES.

## INTRODUCTION.

This Part is mainly a reprint of a memoir on the same subject which was published in the Philosophical Transactions for 1876 as a Preliminary Report on part of the results of the Challenger Expedition.[1] The matter has been, however, rearranged; some new terms have been introduced, and the discussion of the results attained has been modified in order to be in accordance with the facts concerning the Hydrocorallinæ which were ascertained by me since the paper was published. Certain parts of the original paper relating to the structure of *Millepora*, *Stylaster*, and *Pocillopora* have been omitted.

I obtained specimens of the coral *Heliopora cærulea* in the living state at Samboangan, in the Island of Mindanao of the Philippine group, in January 1875. I examined the structure of the coral to some extent whilst in the fresh condition, and made a further detailed investigation of its anatomy during subsequent voyages. For comparison I studied the anatomy of a species of *Sarcophyton* dredged in shallow water amongst the reefs of the Admiralty Islands, and an account of the structure of this Alcyonarian is given here at some length.

Very little had been written on the structure of *Heliopora cærulea* before the first appearance of the present paper, and nothing further containing new information has been added since. The previous accounts referred only to the structure of the corallum or to the appearance of the living polyps, the latter being very imperfect and unsatisfactory. They are referred to as occasion requires in the body of the text.

[1] On the Structure and Relations of the Alcyonarian *Heliopora cærulea*, with some Account of the Anatomy of a Species of *Sarcophyton*; Notes on the Structure of Species of the Genera *Millepora*, *Pocillopora*, and *Stylaster*; and Remarks on the Affinities of certain Palæozoic Corals. By H. N. Moseley, M.A., Oxon., Naturalist to the Challenger Expedition (Phil. Trans. Roy. Soc., vol. clxvi. p. 91, part 1, 1876).

## Methods Employed.

The specimens of *Heliopora* and of *Sarcophyton* examined were hardened in absolute alcohol, being placed in it in the living condition. Portions of them were subsequently decalcified in weak hydrochloric acid, imbedded in wax in the usual manner, and cut into sections. The sections were examined partly in glycerine, partly in Canada balsam, after being rendered transparent by means of oil of cloves. Some sections were stained with carmine. Some portions of *Heliopora* were placed whilst living in a solution of chromic acid, and slowly decalcified whilst in the solution by the addition of a few drops of hydrochloric acid from time to time; these yielded some results which were not obtainable from specimens hardened in alcohol and more rapidly decalcified. Sections of small area were also forcibly cut from the undecalcified hardened corals in order to show the relations of the hard parts to the soft, and separate polyps were removed from their calicles with the point of a scalpel and examined whole in glycerine; portions of the tissues of *Heliopora* were also observed in the fresh condition. For examination of the structure of the hard calcareous tissues, fine sections were prepared by grinding in the usual manner.

## Observations on *Heliopora cærulea* in the living condition.

*Heliopora cærulea* was found growing in abundance on the reefs fringing the shore of the small island of St Cruz Major, which lies opposite the harbour of Samboangan, Mindanao, Philippine Islands. The coral grew in about two feet of water at low tide. It has a uniform light chocolate-colour when fresh and living. Although I transferred portions of the living coral to a glass vessel under water, so that they never came in contact with the air, I did not succeed in getting the polyps to expand; and I have not seen them in that condition, although directly the coral was left at rest a swarm of a species of *Leucodora*, closely resembling *Leucodora nasuta*, which infests the coral and perforates it all over, expanded themselves at once. Most unfortunately I hardened in spirits portions of *Heliopora* taken from only one colony, as I did not suspect that the animal would prove to form unisexual colonies. This colony proved to be female; and hence I have not seen the male generative organs of *Heliopora*.

## Structure of the Corallum of *Heliopora cærulea*.

The genus *Heliopora* was formed by Blainville (Manuel d'Actin., p. 392). It is thus characterised by Milne-Edwards (Hist. Nat. des Corall., t. iii. p. 230) :—" Corallum massive,

lobulate, and rising in a tuft. Cœnenchym very abundant, and presenting at its surface a great number of rounded pores disposed with regularity and separated by projecting papilliform grains. These grains are formed by the upper extremities of an equal number of cylindrical and vertical beams, which shut in tubuliform spaces, open above, and divided from space to space by cross partitions. Calicles circular. Septa very little developed, but distinct, and twelve in number. Horizontal floors present and well developed. The genus is remarkable for its alveolar appearance and the tubular structure of the parenchym."

The coral is figured by Milne-Edwards, *l.c.* (pl. i. fig. 3, *a–c*). A drawing of the growing tip of a frond, much enlarged, will be found on Plate II. figs. 10 and 11 of this paper. The following points require to be remarked concerning the structure of the corallum. The papilliform eminences described by Milne-Edwards as covering the surface of the corallum spring from the points of apposition of the walls of several of the cœnenchymal tubes, very usually from the point of meeting of the mouths of four tubes (Pl. II. fig. 11). At these points the hard tissue consists of thickened vertical beams of calcareous matter, from which thin lamellar-like processes are given off. These processes form the walls between two contiguous tubes by crossing to join similar processes from adjacent beams. Each beam thus gives off four lamellar processes, which are disposed roughly at right angles to one another. The narrow summits of the thin laminæ forming the sides of the tubes fall short in their centres, by a considerable distance, of the level of the thickened masses from which they spring, and are excavated or hollowed out at these spots. It is across these excavations in the laminæ that the canals of the deep system pass in the fresh condition of the coral, by means of which the cavities of the tubes and polyps communicate freely with one another. The structure of the cœnenchym of the coral might perhaps be better described by saying that it consists of a series of tubes of circular section, and of nearly uniform diameter, closely packed side by side more or less in regular rows, with their walls where touching fused together, and the spaces necessarily resulting from such an arrangement at the meeting-points of every three or four contiguous tubes filled in with calcareous matter, so as to form rods or beams of hard tissue, which are elevated above the margins of the tubes into papilliform prominences. Milne-Edwards distinguishes between the tabulæ of the cœnenchymal tubes and those of the calicles, calling the first "traverses," and the second "planchers horizontaux," but they are essentially similar structures. Though twelve is a common number for the projecting plications of the margin of the mouth of the calicle, the number is very variable—11, 13, 14, even 15 or 16 of these so-called septa are to be counted not uncommonly. In the enlarged figure of a calicle (Pl. II. fig. 11) Dr Wild has drawn fifteen. The plications become less numerous at a slight depth in the calicle, and often here are only eight in number, with a mesentery of the polyp passing to each internal projection.

The fine structure of the hard tissue of the corallum of *Heliopora* is in many respects similar to that of the coralla of Hexactinian corals. It is composed of doubly refracting calcareous matter, which has a half-crystalline, half-fibrous structure. On transverse section (Pl. I. fig. 4), it is seen to be made up of a series of systems of radiating fibres, *i.e.*, areas of calcareous tissue showing a radiate fibrous structure. In each system the fibres radiate from a central axis, and diverge to fuse at the margin of the system with the margins of the contiguous systems, a suture-like line being often observable where two systems join. The fibres are disposed more or less in laminæ which overlap one another. The radial fibrous structure is to be seen only in thin slices or fragments of the coral viewed by transmitted light. The fracture of the coral is irregular and crystalline. The central axes of the systems correspond to the centres of the vertical beams already described, which are prolonged above on the surface of the coral into papilliform projections. In a vertical section of the corallum (Pl. II. fig. 5, D), these axes are seen to take a vertical course within the beams and branch beneath the newly formed buds of the cœnenchym. The fibres are seen starting from the axes, spreading right and left from them throughout the tissue with a uniform inclination upwards (*i.e.*, towards the surface of the corallum). In the plates forming the sides of the tubes (Pl. II. fig. 5, B) the sutures between the fibres meeting one another at an angle from the two systems are well marked. The appearance of a portion of the hard tissue, as seen under a high power, is shown in Plate II. fig. 6, where the appearance of the overlapping laminæ is to be remarked. In the corallum of *Pocillopora* definite rod-like prisms with polygonal ends are seen to exist when these structures are viewed end on; in *Heliopora* such a definite structure apparently does not occur.[1]

The transverse partitions in the tubes and calicles give evidence in their structure that they are later additions to the insides of already formed tubes. They are not merely transverse floors, but flat-bottomed cups of tissue fitted inside the old tubes, and thus narrowing their bore considerably in the region where they become formed. In nearly all instances the old boundary line of the tube below the tabula can be traced, and is seen to continue its course for some distance beyond and above the tabula (Pl. II. figs. 5, 9). The tabulæ of the cœnenchymal tubes seem in all respects identical in structure with those of the calicles.

The structures which form the centres from which the systems of hard tissue radiate have here been called axes. They have the appearance of being canals in the hard tissue, but this appearance seems to be fallacious. They probably represent the points of junction of the walls of the opposed cœnenchymal tubes where imperfect fusion has taken

[1] The radiating components of the hard tissue are here spoken of as fibres to distinguish them from these well-marked prisms of which the hard tissue of *Pocillopora* is composed. The exact nature of the radial striæ seen in the tissue of the *Heliopora* I do not understand; they seem to represent spaces between variously shaped splinters, as it were, of hard matter arranged so as to form laminæ.

place between these walls, and the interspace has been filled with amorphous rather than fibrous calcareous matter. In some cases, in transverse sections, these axes appear as elongated spaces between the adjacent tubes, rather than central canals. The appearance of the axial structures is accurately represented in Plate I. fig. 4. There is always a somewhat opaque, fine, granular area around them, which often shows a series of concentric zones.

The opaque tissue surrounding the axes is continued into the projecting points at the surface of the coral. These points sometimes show a banded appearance, as if they had received in growth successive caps of hard tissue (Pl. II. fig. 5, P).

## Mode of Growth of the Corallum of *Heliopora cærulea*.

If a rapidly growing tip of a frond of *Heliopora cærulea* be carefully protected from injury and macerated in potash, the appearance of its corallum will be that given in Plate II. fig. 10. The tissue at the actual tip is seen to be much more delicate and spongy-looking than in the older parts. It consists here superficially of an aggregation of thin-walled cells, which are mostly multiangular in outline at their mouths, sometimes hexagonal, often pentagonal, often with curved sides, assuming these various forms apparently from mutual appressure in growth. In the angles, where the walls of the adjoining cells meet, are the commencements of new cells, which in their very earliest stages are often triangular in superficial outline (see diagram). Amongst this mass of polygonal cells new calicles are developed by the arrest in growth of one or more cells after they have reached a certain small height. The arrested cell or cells form a central floor to the new calicle, around which lies a circular zone of contiguous, deeper, and older cells. The inner walls of these cells, *i.e.*, those nearer to the centre of the growing calicle, cease to grow, whilst their outer ones continue to develop, and being fused together form the lateral walls of the calicle. The plications in the wall of the fully-formed calicle are to a great extent the result of this peculiar mode of growth; but not entirely so, for sometimes in a young calicle two plications are present which may be seen to correspond to one lateral tube only. This will be understood by reference to Plate II. figs. 10, 11, and also to Plate II. fig. 9, where at B a section of a newly-formed calicle is given.

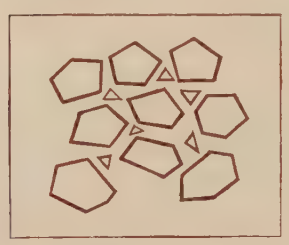


Diagram illustrating the mode of growth of the corallum of *Heliopora cærulea*.

From the peculiarity of the mode of growth above described it results that in a newly-formed calicle the cavity is comparatively shallow in the centre, but is prolonged at the bottom all round into a series of tubular offsets. Into these tubular offsets the

mesenterial filaments hang down in the fresh condition of the coral. On further simple growth the tube of the calicle becomes elongated, and receives a new uniform bottom in the shape of a tabula. As the calicle approaches maturity, the tubes immediately around it become nearly occluded at their mouths by increased development of calcareous matter at its margin. In older parts of the corallum the mouths of all the tubes are rendered very small by the excessive thickening of their walls and of the beams of hard tissue which bear the projecting points. On a quickly expanding frond of the coral the mouths of the rows of cœnenchymal tubes, which are rapidly increasing in length, are disposed in almost regular straight or curved lines directed towards the points of extension. In this condition the lateral walls of the tubes of each line frequently fuse, and become common to the line, and being more fully developed and prominent than the transverse walls, come thus to form long delicate ridges with projecting points on their edges, running almost parallel to one another, and with troughs between them. In these troughs calicles may arise, being most irregular in outline at first but gradually becoming shapely by taking in surrounding cells. In some cases the point-like prominences at the margins of the walls of the cells included within a newly formed calicle may be seen at the bottom of the calicle, maintaining a disposition parallel to that of the trough in which the calicle has been formed.

These lines of tubes may be termed lines of growth. The calicles show a more or less marked disposition in transverse curves, cutting the lines of growth at right angles.

The development of the *Heliopora* colony probably takes place somewhat as represented in Plate II. fig. 9. The original calicle (A) increases in length and forms successive chambers, A′, A″, A‴, A⁗, by developing tabulæ in its interior. It gives off a series of buds from its margin, which become elongate tubes divided into compartments in the same manner, and which in their turn give off buds. New calicles are formed as at B in the figure.

## Mode of Deposition of the Hard Tissue in *Heliopora cærulea*.

Everywhere in the living portions of the coral applied to the surface of the hard tissues is found a layer composed of elongate connective tissue cells. The cells are nucleate and are finely granular in appearance, and are frequently drawn out into fine filaments at the ends. These cells occur only in connection with the hard tissue, excepting in the superficial layer of the mesoderm beneath the epidermis, Plate II. fig. 4. In the median plates of the mesenteries, for example, where no calcareous matter is formed, they are wanting, and homogeneous connective tissue alone present. It seems hence almost certain that they are the instruments of formation of the calcareous tissue. The newly-formed and growing points of the corallum yield much more organic remains after treatment with

acids than the older portions. If one of these small points, after having been treated with a strong solution of potash, be examined under the microscope, it will show apparently no trace of consisting of anything but the usual doubly refracting calcareous matter. If it be then slowly decalcified, an investing layer of finely fibrous tissue is gradually brought into view as the lime is removed. The fibrous tissue seems to form an investment to the hard part, or rather to be present only in its peripheral regions, the central part of the piece of corallum appearing to be free, or almost so, from contained fibrous structures, and thus to be more rapidly attacked and decomposed by the acid. In specimens of *Heliopora* which have been slowly decalcified in chromic acid, the appearance presented by one of these growing points as viewed from below is shown in Plate I. fig. 6. Here it will be seen that a mass of tissue composed of extremely fine fibres (B) occupies the space immediately within the layer of connective tissue cells. The fibres composing the mass are disposed in a concentric manner, externally around the centre of the mass, and more internally around two rounded cavities situate side by side in its centre. Appearances similar to this are presented by a section from the surface of *Heliopora*, prepared as described, cut parallel to the surface and viewed from beneath, sometimes two and sometimes one cavity appearing in the fibrous mass. The fibrous masses occupy the position which in the undecalcified coral is occupied by the projecting points of the corallum, and are identical in structure with the small investment of fine fibrous tissue which, as above described, can be obtained from a growing point of the corallum by decalcification. But the quantity thus derived from a portion of the corallum cleaned with potash is very small indeed in proportion to such a mass as that shown in Plate I. fig. 6. The spaces A, B shown in this figure were probably occupied by the central parts of two newly-formed excrescences on a projecting point of the corallum, whilst the hard tissue was extended thence for some distance amongst the fibrous tissue. It is, however, uncertain how far this extension reached. I have not been able to prepare such sections of hard and soft parts in contact as permit the elucidation of this question.

I have not seen the finely fibrous tissue in the deeper parts of the coral; but in some preparations traces of residual tissue are to be recognised in longitudinal sections occupying the former sites of parts of the corallum situate at some distance from the surface, as at Plate II. fig. 4, P; but it does not here show the fibrous structure.

It seems probable that the layer of connective tissue cells produces the finely fibrous tissue, and that within this tissue the calcareous matter is deposited gradually from within outwards, the tissue gradually being removed and absorbed as the process continues. The finely fibrous tissue may be termed calciferous. Exactly similar tissue, with similar concentric fibrillation, occurs in similar relations in *Pocillopora*, though in this latter case the connective tissue cells are perhaps absent.

In no part of the growing points of the corallum of *Heliopora* is there any trace of the calcareous tissue being built up of the fusion together of a network of spicules, as occurs in the case of the corallum of *Corallium rubrum* and also in that of *Tubipora*, as was shown to be the case by Perceval Wright,[1] and as may be seen at once by examining the growing end of the tube of a spirit specimen of *Tubipora*. In this respect *Heliopora* differs most markedly from both *Corallium* and *Tubipora*. The structure of the hard tissue of *Heliopora* is, however, in many respects very like that of the sclerites of *Primnoa*.

## Blue Coloration of the Corallum of *Heliopora cærulea*.

The corallum of *Heliopora* is coloured of a deep blue, and has always been regarded as remarkable amongst corals for this fact. Now that it is known to be an Alcyonarian structure the fact is less exceptional, since both *Corallium* and *Tubipora* have a deeply coloured corallum, and many other Alcyonarians have coloured spicules. Amongst Madreporaria such a condition is exceptional, but the coralla of some *Fungias* and *Desmophyllums* is coloured madder red by a peculiar colouring matter which I have termed "polyperythrin,"[2] and which occurs also abundantly in many Medusæ and other Cœlenterata. In the case of certain Eupsammidæ also the corallum is red.

The blue tint is seen in sections of the corallum of *Heliopora cærulea* to be diffused within the hard tissue. The colour is faint or almost absent in the freshly-growing tips of the corallum, and pale in the most recently-formed superficial structures generally; it is darkest in the layer lying immediately beneath these, that is to say, in the most recently matured tissue. In transverse sections it is seen to be darkest at the surfaces of the walls of the tubes and calicles. In vertical sections of the corallum the continuation of the dark blue line marking the margin of the wall of each tube enables the line of the tube to be traced past the superadded tabula, and marks the boundary between the two structures. Very exceptionally, intensely blue streaks are developed more internally on either side of the central canal, as in Plate II. fig. 6, where B marks such a blue band. The usual distribution of the colouring is that shown in Plate I. fig. 4, where the dark zone at the margin of each tube seen in section represents intense colouring. The tabulæ are almost colourless.

When the corallum is boiled for a long period in caustic potash the blue colour remains unaltered. When the calcareous matter is removed from the corallum by means

[1] J. Perceval Wright, On the Animal of the Organ-pipe Coral, Ann. and Mag. Nat. Hist., vol. iii. p. 377, 4 ser., 1869.

[2] H. N. Moseley, On the Colouring Matters of various Animals, and especially of Deep-Sea Forms dredged by H.M.S. Challenger (Quart. Journ. of Micro. Sci., new ser., Jan. 1877, vol. xvii. p. 2).

of hydrochloric acid, the colouring matter is set free, and remaining suspended in the fluid gives it a blue tint. It is, however, not in solution, but can be observed under the microscope to exist in the fluid in the form of small, amorphous, intensely blue masses adhering to small shreds of tissue, &c., and in this condition may be proved to be insoluble in strong hydrochloric acid. If the coloured solution formed by hydrochloric acid be filtered, the blue colouring matter remains on the filter, and the filtrate has only a very slight greenish tint.

The colouring matter is dissolved at once off the filter by alcohol, and an intensely blue solution, very like that of sulphate of copper in colour, is thus obtained. The colour, however, is not dissolved out of the corallum by the action of alcohol alone. The deep blue and alcoholic solution gives a spectrum in which all the violet, red, and yellow are totally absorbed, and the green and blue alone transmitted. The absorption of the violet end of the spectrum extends to the position of the G line of the solar spectrum, that of the less refrangible end to a little short of the E line. Addition of potash or ammonia solutions to the blue solution changes the colour to a dirty green, which is contained in a flocculent precipitate. The blue colour reappears on the solution being rendered acid again.

Dana states that the blue colour of *Heliopora* is of animal origin, and is lost on immersion of the coral in nitric acid. The colouring matter was not analysed by Mr Silliman (U. S. Expl. Exped., vol. vii., Zoophytes, J. D. Dana, Philad., 1846, p. 537).

## Structure of the Soft Tissues of *Heliopora*.

The arrangement of the structures constituting the general superficial layers of *Heliopora*, and of those common to the cœnenchymal tubes and calicles, will be considered in the first place, and in the second the structure of the polyps themselves.

As in other Alcyonarians, the various structures are to be classed as belonging to an ectoderm, a mesoderm, and an endoderm. The general arrangement of these three layers of tissue will be seen in Plate I. fig. 1.

*Ectoderm.*—The ectoderm consists of a layer of cells, which invests the whole external surface of the coral with a uniform covering. Its structure is shown in Plate II. fig. 4. The cells composing it are elongate and club shaped, with wide rounded summits and pointed lower extremities which run out into fine threads which can be traced some way into the layer beneath them. The cells contain a nucleus and nucleolus, and their general contents are finely granular; they are closely packed side by side, placed parallel to one another, and vertically to the surface of the coral. When the external layer is viewed from above, the ends of the cells present a series of polygonal areas. The cells are about ·02 mm. in length. Between the contracted bases of these cells are other irregularly shaped cells with similar nuclei and contents, and also scattered throughout

the layer are to be found nematocysts. The ectoderm is prolonged to form the lining of the stomachs of the polyps; otherwise it is superficial only.

The mesoderm consists of three different histological structures:—(1) A nearly homogeneous transparent connective tissue; (2) layers of connective tissue cells; and (3) masses of finely fibrillar tissue.

(1.) Beneath the ectoderm is a thick layer, of a mean thickness of about ·07 mm., likewise extending over the whole surface of the coral, which consists of a highly transparent connective tissue, which is almost homogeneous, but in which faint lines indicating slight fibrillation may here and there be seen.

Extensions of this homogeneous layer form the central layers of the membranes lining the cœnenchymal tubes and calicles, and the median plates of the mesenteries, part of the wall of the stomach, &c. The layer of mesoderm immediately beneath the ectoderm is pierced by the superficial system of canals and traversed by the projecting points of the corallum (Pl. II. fig. 4).

(2.) Imbedded within the superficial homogeneous layer of the mesoderm occur also fusiform and branched connective tissue cells, which are associated together in elongate, often nearly linear groups (Pl. II. fig. 4). Many of these cells are branched, throwing off fine filamentous processes in various directions. Layers of similar cells lie everywhere next apposed to the hard tissues of the living corallum, as has already been described. These cells do not compose any portion of the polyps themselves, but merely line the calcareous calicles.

(3.) In decalcified preparations of *Heliopora* enclosed within the layers of connective tissue cells, at the places before occupied by the growing points of the corallum, occur the masses of very finely fibrillar calciferous tissue already described (Pl. II. fig. 4, P). Both this and the corallum itself belong to the mesoderm.

*Endoderm.*—The endoderm consists of spherical cells, each with small transparent nucleus, and contents consisting of irregular yellow pigmented masses and dark coarse granules. They have a mean diameter of about ·014 mm., but vary much in size. They are most probably ciliated in the fresh condition, as are the closely similar endodermal cells of other Alcyonarians. I have not been able to see cilia in the hardened specimens which I have examined; nor have I in these specimens been able to detect differences between the endodermal cells lining the cavities of the calicles and tubes and those lining the canals. Some of the cells show a division of their contents into four (Pl. II. fig. 7, $a$, $a'$). The endodermal cells form layers lining the canals, the cœnenchymal tube cavities, the cavities of the calicles, and interseptal spaces.

*Soft Tissues of the Tubes and Calicles.*—The cœnenchymal tubes in their upper cavities are thus lined throughout by a membrane consisting of three layers, viz., an outer layer of connective tissue cells, a middle layer of homogeneous connective tissue, and an inner lining layer of endodermal cells. The calicles are lined throughout in like

manner. The arrangement will be seen in Plate I. fig. 4. In the membrane lining the calicles, in transverse sections, a peculiar structure (shown Pl. I. fig. 3) is to be constantly observed. Stout offsets from the median connective tissue layer pierce the outer layer of connective tissue cells, and hang loose externally as flattened tags, which appear as if broken off, and are often somewhat curled up. I have been unable to determine the connection of these tags of tissue with the calicular wall (Pl. I. fig. 3). Exactly similar structures occur in *Tubipora*, being specially developed around the lower part of the polyps. Beneath the uppermost tabulæ scarcely any organic lining remains to the tubes, if any at all, and the deeper central parts of the corallum are, in the specimen of *Heliopora* which I have examined, almost entirely filled with the tubes of the boring annelids (*Leucodora* sp.). Thus when a mass of *Heliopora*, after being hardened, is decalcified, the whole of the deeper parts are removed, and a thin layer of soft tissue only remains behind, which above presents a similar appearance to that of the surface of the undecalcified coral, but beneath is seen to be composed of a series of villous processes derived from the tubes with the bottoms of the calicular sacs appearing as tubercles amongst them. Since the tubes of the cœnenchym and calicles have no lateral connections with one another except close to the surface of the corallum, in decalcified preparations they are, excepting at their very upper extremities, entirely separated from one another; hence it is extremely difficult to prepare fine transverse sections in the deeper regions, since the structures afford no support to one another.

*Canal Systems.*—The summits of the cavities of the sacs of soft tissue lining the cœnenchymal tubes communicate freely with one another and with the cavities of the polyps by means of a system of short transverse canals, which cross over the margins of the walls of the calcareous tubes at the lower parts of their mouths, as already described, p. 104, and shown in Plate II. fig. 7. These canals are mostly very short; they are circular in section, and have the same three layers in their walls as which compose the sacs within the tubes. In older parts of the coral, where the calcareous tubercles on the surface are much developed and the mouths of the cœnenchymal tubes are consequently contracted, a series of open channels are to be observed in the corallum running at the bases of the tubercles, when the coral is looked at with a hand magnifier. It is in these channels that the system of transverse canals runs. This canal system I have termed the "deep canal system," to distinguish it from the system of smaller canals lying superficially to it. The tube cavities communicate with the polyp cavities by means of the deep canal system, through a system of large apertures shown in Plate II. fig. 2. These apertures open in the intermesenterial spaces all around the summit of the calicle at its periphery, a single aperture being situate in the space formed by each externally projecting fold of the calicular wall.

The superficial canal system consists of a series of small canals and sinus, which take

mostly a more or less vertical direction and communicate directly with the deep canal system. These superficial canals anastomose with one another by horizontal offsets. A series of horizontally extended canals of this system may be seen to surround each polyp, when in the contracted condition, the canals having then a radial arrangement. One such canal is shown in vertical section in Plate II. fig. 1, and the appearance of the summits of the canals as seen from the surface of the coral is shown in Plate I. fig. 5. The superficial canals are not only lined by, but also always more or less filled with endodermal cells, at least in hardened specimens of the coral.

Openings to the exterior other than those of the polyps were carefully sought for over the surface of *Heliopora*, but without success. The spots from which, by decalcification, growing tips of corallum have been removed, often form themselves into apertures in horizontal sections, and are apt to mislead the observer.

*Nematocysts.*—Nematocysts occur, as already described, amongst the cells composing the ectoderm, and also in the layer of mesoderm lying immediately below the ectoderm. They were not observed in the tentacles of the polyps or elsewhere. They are extremely small, measuring only ·009 mm. in their longest diameter. They are of an ovoid form, and contain a single filament within, wound in a spiral, the axis of which corresponds with the long axis of the cell. They are often to be seen with the thread emitted and twisted in a loop against the side of the cell. The cell after the ejection of the thread often assumes a reniform shape (Pl. II. fig. 7, *b*, *b'*). They are so small that they might readily be overlooked, and a very high power is required to determine their structure. They appear to be not very abundant. They are shown *in situ* in Plate II. fig. 4, NN.

*Structure of the Polyps.*—The polyps of *Heliopora* have been examined by me only in a contracted condition.

When the contracted polyps are viewed from the interior, they show (Pl. I. fig. 5) eight symmetrically and radially disposed lobes, which form a covering closing the mouth of the calicle. The lobes are separated by deep sulci corresponding to the insertions of the eight mesenteries into what would be, in the expanded condition of the animal, part of the lateral wall of the polyp. They show a distinct striation in the direction of their length, indicating probably the presence of fine muscular fibres in their substance. At their inner region the lobes show, near their common centre, a number of extremely small nuclei upon their surface. As may be seen in Professor Lacaze Duthier's memoir on *Corallium rubrum*, the contracted polyps in that species present externally at the surface eight red coloured lobes, closely similar in form to those of *Heliopora cærulea*. When the polyps are expanded these lobes form a coloured cup with eight dentations at its margin, which cup surrounds the lower part of the expanded colourless polyp.[1] The

[1] H. de Lacaze Duthiers, Histoire Naturelle du Corail, pl. ii.

eight lobes of *Heliopora* just described probably occupy a similar position and have a similar appearance in the expanded condition of the polyps.

*Tentacles.*—From the centre of the disk of lobes a tubular cavity, which may be called the atrium, leads down directly to the mouth (Pl. I. fig. 1). Around the mouth and just above it, orifices of the eight tubular introverted tentacles open into the atrium. The tentacles in the retracted condition are completely introverted and appear as tubes, the inner cavities of which would, in the expanded condition of the polyp, form the outer surface of the tentacle. The cavities of the introverted tentacles communicate directly with the atrium, as may be seen in vertical sections, by orifices which show in the centre a cruciform lumen (Pl. I. fig. 1, T′) formed by the folds of the ectodermal lining of the tentacular cavity. The retracted tentacles are directed at first horizontally outward from the atrium, and then turned downwards at nearly right angles to their former course. They rest in the intermesenterial spaces. Transverse sections of four of them are seen in Plate I. fig. 3. The cavities of the introverted tentacles are lined by a direct continuation of the ectoderm, which passes down over the inner surface of the atrium to enter the cavities. In their interior the ectoderm is elevated into a series of short stout tubercles, which no doubt project much more in the expanded condition of the tentacle, rendering it compound as in other Alcyonarians. In the retracted tentacles, as seen in Plate I. fig. 3, three layers, outer endodermal, median connective tissue, and inner ectodermal, can be readily distinguished. The median probably contains muscular structures, but I have been unable to see them. In *Corallium rubrum* the pinnæ or barbules of the tentacles are all severally introverted, as well as the tentacles themselves, in *Heliopora* such appears not to be the case.[1]

In the atlas of the Voyage de l'Astrolabe,[2] the expanded polyps of *Heliopora cærulea* are figured by MM. Hombron and Jacquinot; in figure 14 sixteen very short simple conical tentacles are shown, in figure 13 only fifteen tentacles. The figures are evidently very erroneous.

In the zoology of the Voyage de l'Uranie[3] is a description of the polyps of *Heliopora cærulea*, but without any figure of them, by MM. Quoy and Gaimard, the substance of which is as follows :—The expanded polyps have radiated tentacles and entirely hide the corallum when in an expanded condition. Experiments proved that the communication between the polyps is somewhat imperfect, since a stimulus applied to any part of the colony only caused the polyps in that immediate neighbourhood to contract themselves.

The authors appear to have mistaken at first the expanded parasitical *Leucodoras* for

[1] H. de Lacaze Duthiers, *loc. cit.*, p. 57.

[2] Hombron et Jacquinot, Voyage au Pole Sud de l'Astrolabe et Zelle, Paris, 1842–53, Zoophytes, pl. xxix. figs. 12–14.

[3] Quoy et Gaimard, Voyage de l'Uranie, Paris, 1824.

the polyps of the *Heliopora*. Hence, possibly, the observed lack of propagation of applied stimulus. In their later work[1] they write as follows:—"M. de Blainville's observations on the animal of *Heliopora cærulea* led him to remove it from the genus *Pocillopora*, in which it had before been placed, and to form the genus *Heliopora* for it, because the animals of *Pocillopora* have never more or less than twelve tentacles. *Heliopora* has either fifteen or sixteen short, broad, triangular, pointed tentacles forming a disc around the mouth. The animals were made out with difficulty with a powerful lens." Eight compound tentacles appear to have been mistaken by the observers for sixteen simple ones.

*Stomach.*—The stomach of *Heliopora* is closely similar to that of other Alcyonarians. As seen in the contracted condition its walls are horizontally plicate. In transverse sections, as Plate I. fig. 3, the layers composing its walls are well seen. There is the usual covering of the endoderm; but in the mesoderm, within the layer of homogeneous connective tissue, a second narrow zone (Pl. I. fig. 3, B) can be detected which is probably muscular. The inner ectodermal lining of the stomach is continuous with that of the tentacles, but ciliated.

*Mesenteries and Muscles.*—Eight mesenteries completely divide the upper part of the cavity of the polyp into eight radially-disposed chambers. The mesenteries consist of a median plate of homogeneous connective tissue, which is directly continuous with the similar layer of the lining membrane of the calicular cavity, and also with that surrounding the stomach, and of an investment of endodermal cells covering the median plate on both sides, excepting where the retractor muscles intervene between the two. The retractor muscles form the lower borders of the mesenteries; they consist of long stout fibres which, lying on the surface of the mesenteries, take origin from the lower part of the sides of the polyp-cavity, and reach sometimes as far down as the margin of the tabula. They curve thence inwards and upwards, becoming gradually more concentrated as they ascend, and are inserted round the mouth and region just below it, in the intervals between the bases of the tentacles.

The muscles have in position, with regard to the plates of the mesenteries, the same arrangement which Kölliker[2] has described as existing in the Pennatulidæ,[3] and which has also been found in the genus *Umbellula* by Lindahl and figured by him.[4]

The arrangement of the muscles is seen in Plate I. fig. 3, where R M, R M are the muscles. At opposite ends of the long axis of the stomach the muscles are on

[1] Quoy et Gaimard, Voyage de la Corvette l'Astrolabe, Paris, 1832, t. iv., Zoophytes, pp. 252, 253.

[2] Prof. Kölliker, Anatomisch-systematische Beschreibung der Alcyonarien, Abh. dersensk. naturf. Gesell, Frankfurt, 1870.

[3] "Om Pennatulidslägtet *Umbellula*," Kongl. Vet. Akad. inlemnad den 10. Feb. 1874 : Stockholm, tab i. fig. 8.

[4] Professor Schneider and M. Rötteken must certainly have been mistaken in their conclusions concerning the arrangement of the muscles with regard to the mesenteries in Alcyonaria, if the figure given in the Ann. and Mag. Nat. Hist., 1871, vol. vii. p. 437, as representing them be correct.

opposite sides of the mesenterial plates. The mesenterial chamber (seen beneath in the drawing), which is free of muscles, is the "Dorsalfach" of Kölliker; the opposite one the "Ventralfach." The muscles are covered by the endodermic layer, and are in direct contact with the median plates of the mesenteries, being modifications of the mesoderm.

I have not been able to find any definite protractor muscles in *Heliopora*. I have, however, occasionally seen fibres on the surface of the mesenteries of the lateral margins of the atrium, coming apparently from the stomach-wall, which may prove to be such. In transverse sections I have seen no trace of such muscles.

*Heliopora* having commonly twelve so-called "septa" and eight mesenteries, a definite and regular relation of the eight mesenteries to the twelve plications of the wall of the calicle might naturally be looked for; none such, however, exists. As has been before stated, the number twelve is by no means constant, and where twelve are present the arrangement varies in all kinds of ways. In Plate I. fig. 3 the plications are shown as seen in an actual section, and their relations are accurately copied. Here there may be counted either twelve or thirteen such plications, representing corresponding calcareous septa which occupied the indentations.

There are eight mesenterial filaments, as usual, present, which spring from the angle where the retractor muscles are inserted into the stomach-wall, and are continued down the free borders of the muscles, being attached to them. The filaments have the usual structure. Two filaments appear to be constantly longer than the others; but I am uncertain about this point, it being very difficult to get a view of all the filaments uninjured in any one polyp. To which sides of the mesenterial plates the filaments are attached I have not made out.

*Generative Organs.*—Out of at least a hundred polyps examined from the colony of *Heliopora* hardened for examination, only three were found to contain generative organs; in each of the cases ova. In two of the polyps a single ovum only was present, in the third four ova attached singly to four mesenteries. The ova are attached to the edges of the muscular margins of the mesenteries at a point about halfway between the origin and insertion of the fibres composing the lower border of the muscle (Pl. I. fig. 1). The ovum is attached to this border by a specially developed mass of endodermal cells, and at its point of attachment is in close relation with the mesenterial filament. The ova, as shown (Pl. II. fig. 8), are large, measuring ·21 mm. in diameter (the smallest observed measured ·17 mm. in diameter); they are composed of an outer membranous capsule, by means of which they are attached in position, and a contained mass of yelk-globules, in which lies a germinal vesicle and germinal spot.

It was not determined which of the mesenteries bore ova, or whether those with long filaments bore them or not, the expectation that abundance of fertile polyps would be

found for examination having been disappointed. In Plate I. fig. 1 the mesenterial filament is, in the drawing, stopped short above the ovum in order to allow the ovum to be seen. The filaments belonging to the septa bearing ova hang down below the ova. No trace of any male elements was found in any polyp. The colonies of *Heliopora* are probably unisexual.

*Disposition of the Dorsal and Ventral Aspects of the Polyps.*—The investigation of the positions of the dorsal and ventral aspects of the polyps in the *Heliopora* colony relatively to the axes of growth is extremely difficult, because, when a horizontal section is cut sufficiently deep down to display the muscular arrangement, nothing remains to hold the various sections of polyps in position but the imbedding substance made use of; and where the only substance at command, as in the present case, was wax, the sections with the wax unremoved were found almost too opaque and indistinct for observation. By examining such sections, held together by the wax and made transparent with glycerine, I have found that the polyps (although they are often turned on their central axes to a considerable extent, so that the long axes of their stomachs are not by any means parallel, but often inclined to one another at very considerable angles) have nevertheless their dorsal surfaces, or the intermesenterial spaces devoid of retractor muscles ("Dorsalfächer"), always nearer to the summits of the colony than are the "Ventralfächer." The "Dorsalfächer" thus show a general tendency to take a superior position, *i.e.*, lie uppermost, in the vertical plates of which the colony is composed. The entire coral makes up a flat plate, with two outer surfaces, towards which the polyp-tubes are directed in curves on either hand from the vertical axis of growth; and the polyps thus curving away from one another have their "Dorsalfächer" approximated, or may be said to be placed back to back.

## On the structure of a species of *Sarcophyton*.

An Alcyonarian dredged in shallow water amongst the reefs on the shores of the Admiralty Islands was examined in order to compare its structure with that of *Heliopora*. The Alcyonarian in question appears to belong to the genus *Sarcophyton*, Lesson,[1] originally described in the Zoologie du Voyage de la Coquille, and possibly to his species *lobatum*.[2] The genus is stated by Milne-Edwards to be imperfectly known. The specimens correspond in every particular with the description as given by Milne-Edwards. The Alcyonarian has exactly the form of a mushroom, with a cylindrical stem and polyps confined to the upper surface of the pileus. Many specimens were obtained, but unfortunately only one was retained for dissection during the voyage, the remainder packed away.

[1] Milne-Edwards and Haime, Hist. Nat. des Coralliaires, tom. i. p. 122.

[2] Zooph., p. 92, 1831.

In this specimen the pileus is about 5 cm. in diameter, being somewhat oval in outline; the height from the bottom of the stem to the summit of the pileus is also about 5 cm.; the diameter is about 1·5 cm. The colony is of a uniform brown colour.

On examination the *Sarcophyton* was found to present many points of interest, especially in comparison with *Heliopora*; a short description of its anatomy will therefore be given.

*Terms.*—As in Pennatulids, two kinds of individuals, sexual and asexual, compose the *Sarcophyton* colony. Such individuals have been termed by Kölliker polyps and zooids, the latter term denoting the sexless or partly aborted polyps, which act mainly as pores for the regulation of the water supply of the colonies. I propose to term in the case of Alcyonarians, in which there are two kinds of zooids, the sexual forms "autozooids," and the aborted polyps (zooids of Kölliker) "siphonozoids."

*Structure of the Zooids.*—The stem of *Sarcophyton* consists of a series of tubular canals running parallel to one another vertically, and bound together by abundant transparent connective tissue, in which are closely packed, numerous, stout, calcareous spicules of the common elongate cylindrical form, pointed at both ends, and covered with small lateral tubercules. The canals are prolongations of the autozooid cavities from above. The surface of the stem and under-surface of the pileus are covered with an even coat of epidermis, and entirely free from zooids of both kinds. On the upper aspect of the pileus the surface is covered all over with autozooids and siphonozooids. Over the general upper surface the autozooids are pretty evenly distributed at intervals, the interspaces being filled by numerous siphonozooids; but at the margin of the pileus, where its edge is turned down and slightly recurved, is a narrow zone all round, occupied by thickly set autozooids with very few siphonozooids. In a vertical section through the central axis of the whole colony, the autozooid tubes are seen to be arranged with great regularity, converging in curved or vertical lines, according to position, towards the stem. The circular areas occupied by the retracted autozooids measure 1·4 mm. in diameter, those occupied by the siphonozooids ·42 mm. in diameter—the difference in dimensions being here much less than in deeper regions of the colony, where the autozooid cavities widen and the siphonozooid cavities contract. There are narrow intervals between the circular areas, in which there project the thickly set tips of spicules, which show through the epidermis (Pl. II. fig. 3) and form stiff supports to the walls of the cavities.

*Autozooids.*—The structure and relations of the autozooids and siphonozooids are seen in Plate I. fig. 2. The autozooids present no remarkable features; they have numerous fine spicules in their tentacles, which are, as is usual, simply retracted, and are provided with protractor and retractor muscles. Of the protractor muscles (PM in Pl. I. fig. 2) part of the fibres appear to be inserted into the wall of the autozooid cavity, whilst others are continued on the inner borders of the mesenteries.

The muscles in the autozooids are arranged with regard to the septa as in *Heliopora*, *Pennatula*, and *Umbellula*, showing a dorsal and ventral intermesenterial space. The protractor muscles are placed on the opposite sides of the mesenterial plates to those occupied by the retractors. Two mesenterial filaments are longer than the rest; probably they are those of the "Dorsalfach," since the only two retained by the siphonozooids are the dorsal ones. The ova are developed deep down in the autozooid cavities; they have the usual form of the ova of Alcyonarians, and measure, when mature, about 7 mm. in diameter. They are placed in Plate I. fig. 2 at a greater height in the cavity of the autozooid than that at which they usually occur. Ova are to be found in the tubular prolongations of the autozooid cavities very deep in the colonies, whilst the tubular cavities of the siphonozooids have a diameter of about ·35 mm. The autozooid cavities widen out beneath the surface to contain the autozooids and gradually contract again below; they have an extreme diameter of 2 mm.

*Siphonozooids.*—The siphonozooid cavities are only about one-fifth the length of the autozooid cavities. The siphonozooid cavities contract below and their tubes gradually narrowing join the canal-system, as is described by Kölliker to be the case in *Sarcophyllum*.[1] The siphonozoids (Pl. II. fig. 3) consist of a simple globular stomach lined within by a thick epithelium, a prolongation of the ectoderm, and communicating with the exterior by a narrow tubular mouth; they have no trace of tentacles. The inner surface of the stomach is covered with long cilia directed downwards and inwards. Near the surface of the body, just beneath the ectoderm, eight mesenteries are present in all the siphonozooids; but four of these extend to a much less depth than the others, and hence in a horizontal section at a very slight depth from the surface all the siphonozooids in section are seen with only four mesenteries. The four deeper mesenteries are those attached to the ends of the long axes of the stomach, *i.e.*, the dorsal and ventral. Only two mesenterial filaments, those of the dorsal mesenteries, are developed in the siphonozooids. The filaments are attached throughout their length to the margins of the septa. The siphonozooids are without sexual organs.

*Sarcosome.*—The external surface of *Sarcophyton* is covered with an ectoderm resembling in structure that of *Heliopora;* it was not sufficiently well preserved in the available specimen to show its exact structure. No nematocysts were found in *Sarcophyton*. The mesoderm forms a general supporting mass consisting of tough, gelatinous, transparent connective tissue, in which are distributed, somewhat sparsely, very small finely ramified nucleate corpuscles. In the walls of the siphonozooid and autozooid cavities, when viewed from their surfaces, there is to be seen a transverse fibrillation of a part of the mesodermic layer composing them; and these walls, when seen in section on

[1] Kölliker, *l. c.*, 1te Abth. Taf. viii. fig. 68.

edge, show plainly a layer next the cavities of the zooids consisting of well differentiated fibres disposed transversely to the lengths of the cavities.

The sclerites or spicules are imbedded in the thick layers of the sarcosome intervening between the autozooid and siphonozooid cavities and between the tubes composing the stem, and also occur in the tentacles of the autozooids. The growing tips of the spicules project amongst the ectodermal cells (Pl. II. fig. 3), carrying with them their investment of connective tissue. When the spicules are removed by acid, corresponding cavities are left in the mesoderm. A transparent membrane can be distinctly seen investing closely each spicule; no fibrillar or cellular structure, however, could be seen in the membrane.

The autozooid and siphonozooid cavities, and the whole of the canal system, are invested as usual by an endodermal layer, consisting of spherical cells with yellow contents exactly like those of *Heliopora*. In the siphonozooid cavities, at their summits, around the top of the stomach, masses of these cells were always observed to be accumulated. Possibly the accumulation of these in this situation is consequent on action taking place on the death and contraction of the colony when placed in spirits.

*Vascular System.—Sarcophyton* is an extremely favourable subject for the examination of the vascular system. In sections from alcoholic specimens preserved in glycerine jelly the whole ramifications of the vessels are most clearly displayed. Owing to the pigmentation of their lining endoderm, the canals show out dark and defined in the perfectly transparent connective tissue. The arrangement of the canals is shown in Plate I. fig. 2.

Two systems of canals are to be distinguished—the transverse and vertical systems. The transverse canals run parallel to the surface of the colony and to one another in each interspace between the autozooid cavities. They take the most direct courses to connect the cavities of the autozooids with those of the surrounding siphonozooids and with those of the adjacent autozooids. They commence to be given off laterally from the autozooid cavities at their very summits, forming there communications with the siphonozooid cavities. They continue to be given off at tolerably regular intervals, crossing now to a closely situate siphonozooid, now to a distant one. Deeper down in the colony the canals make long stretches to join the next adjacent autozooid cavity, and become shorter and shorter as the autozooid cavities converge below. Similar short canals connect the siphonozooid cavities with one another. Running in a general vertical direction between these transverse canals are the vertical ones, distinguished by their more undulatory course. The chief stems of this system of canals are the direct prolongations of the siphonozooid cavities. In connection with these canals is an irregular meshwork by which the whole deep connective tissue is permeated, and through the meshes of which the transverse canals pass. Offsets of the vertical canal system pass between the siphonozooid and autozooid cavities and give off transverse connecting branches.

There is no surface network of canals present in the superficial layer of mesoderm directly beneath the ectoderm, such as exists in *Heliopora*.

The large canals in the stem of *Sarcophyton*, which are in reality long drawn out prolongations of the body cavities of the autozooids, may be considered as corresponding to Kölliker's "sinus;" the vertical and transverse canal systems to the "canales nutrici majores;" the network in connection more directly with the vertical systems to the "vasa nutrica minora." Apparently there are no vessels corresponding to the "vasa capillaria," their place being occupied by the network formed by the small ramified corpuscles in the sarcosome.

The transverse and vertical canal systems anastomose with one another frequently, but only here and there. Occasionally, but rarely, the canals from the bottoms of the siphonozooid cavities join directly the transverse canals. The canals have a wall of fibrous tissue directly continuous with the fibrous layers of the siphonozooid and autozooid cavities, and are lined internally by endodermal cells (Pl. II. fig. 3, C). Sac-like enlargements or swellings are constantly to be seen on the canals of *Sarcophyton*, both near the surface and in the deep tissue. In one such swelling was found a parasitical cyst of oval form and with greenish contents; its nature could not be determined.

*Disposition of the Dorsal and Ventral Aspects of the Zooids.*—The autozooids in *Sarcophyton* are so disposed that they have the dorsal intermesenterial spaces directed towards the centre of the pileus, and at the verge of the pileus these spaces uppermost. At least this disposition was observed to hold good in three opposed radial directions from the centre of the pileus. A whole specimen was not available for examination.

As in *Heliopora* the autozooids are not disposed with perfect regularity in this manner, so that radial lines from the centre of the pileus would pass directly through their longer diameters. Many of them are rotated more or less on their axes, so as to be inclined to the radial lines. They are most regular in disposition at the margin of the pileus. The siphonozooids, though preserving a general uniformity of arrangement, which proves their single pair of mesenterial filaments to be the dorsal ones, are still more irregular in disposition.

## General Remarks.

*Affinities of Heliopora.*—*Heliopora* is most undoubtedly an Alcyonarian. The number of its mesenteries, and the distribution with regard to them of the retractor muscles, the form and number of its tentacles, are decisive evidence in the matter; and this evidence is borne out by almost every item of histological structure. In the peculiar manner in which the retraction of the tentacles takes place, viz., by introversion, *Heliopora*

seems to differ from all other Alcyonarians except *Corallium*. From both *Corallium* and *Tubipora*, *Heliopora* differs in that the hard tissue of its corallum shows no signs of being composed of fused spicules, but in its histological structure most closely resembles Zoantharian corals. With the Milleporidæ and with *Pocillopora* and *Seriatopora* *Heliopora* is allied solely on account of its possession of tabulæ, and these structures being possessed alike by Hydrocorallinæ, Helioporidæ, Tubiporidæ, and certain Madreporaria, their presence is proved to be of no classificatory importance, and is of less value even than Professor Verrill showed it to be. The group Tabulata must be entirely given up as only misleading in its signification, and the corals formerly placed in it must be distributed amongst their natural allies. There can hardly be a doubt that *Seriatopora* will prove to be, like *Pocillopora*, a Zoantharian. *Heliopora* thus stands quite alone amongst modern forms; and in the peculiar structure of its cellular cœnenchym it is so remarkable that it is unlikely that on examination of the soft parts of other living corals, at present known from their coralla only, any near relatives of it will be discovered. Amongst extinct forms, however, *Heliopora* has several close allies, and the genus itself existed in the Cretaceous period. The genus *Polytremacis* differs apparently only in the more perfect development of the so-called septa, which reach to the centres of the tabulæ. The genus occurs in the Chalk, Greensand, and in Eocene formations. *Heliopora* has, further, a very closely allied palæozoic representative in *Heliolites*, in which the cœnenchymal tubes are provided with very closely placed tabulæ. Professor Alleyne Nicholson[1] groups with these *Plasmopora*, *Propora*, *Lyellia*, and *Pinacopora*; he finds a difficulty in the fact that the cavities of the tubes do not communicate with those of the calicles in *Heliolites*, and appears not to have understood my description of the manner in which the polyp cavities communicate with the sacs of the tube cavities in *Heliopora*. There are no apertures in the walls of the calicles, or tubes in *Heliopora*, any more than in *Heliolites*, and the connecting canals pass, as described, only over the edges of the mouths of the cœnenchymal tubes, lying quite superficially.

The three genera *Heliopora*, *Polytremacis*, and *Heliolites* differ from one another in so slight a degree that they are placed under the one genus *Heliopora* by Queenstedt. For the reception of the genus *Heliopora* and its fossil allies I formed a separate family of Alcyonarians characterised as follows from the recent species.

[1] H. Alleyne Nicholson, On the Structure and Affinities of the Tabulate Corals of the Palæozoic Period, Edinburgh, 1879, pp. 242, 243.

## Characters of the Family Helioporidæ.

A compact corallum present, composed of a fibro-crystalline calcareous tissue as in Madreporaria. Corallum consisting of an abundant tubular cœnenchym, and with calicles having an irregular number of lateral ridges resembling septa. Calicles and cœnenchymal tubes closed below by a succession of transverse partitions. Polyps completely retractile, with tentacles when in retraction introverted. Mouths of the sacs lining the cœnenchymal tubes closed with a layer of soft tissue, but communicating with one another and with the calicular cavities by a system of transverse canals of soft tissue.

*Tubular Cœnenchym of Heliopora and its Homologies.*—The structure of the cœnenchym of the Helioporidæ is entirely unique amongst Anthozoa; no other forms have a cœnenchym composed thus of a series of long tubes packed side by side, and lying parallel to the calicular tubes and at right angles to the surface. It is to be remarked that the tubes are like the calicles in being open above, that they have walls composed in exactly the same manner as those of the calicles, and that they are closed below at intervals in the same way by exactly similar tabulæ. Further, the soft tissues lining the cavities of the cœnenchymal tubes are identical in structure with those lining the calicular cavities, and the same transverse system of canals connects the summits of the tubes with one another, and with the summits of the calicular cavities.

It seems by no means improbable that the cœnenchym here is composed of the tubes of aborted zooids (siphonozooids) which have lost the rudimentary organs, which they still possess in such a form as *Sarcophyton*, and have become mere tubular cavities, the openings of which to the exterior even have been obliterated; it seems impossible otherwise to account for the presence of the succession of tabulæ in the cœnenchymal tubes.

*Fossil Allies of the* Helioporidæ.—The foregoing considerations are suggested by the circumstance that a series of fossil corals, grouped by Milne-Edwards under the Tabulata, appear most probably to have been Alcyonarians as well as *Heliopora*. The genus *Chætetes* was considered by Keyserling to have belonged to the Alcyonarians, because of the absence of septa and the mode in which its polyps are grouped; but Milne-Edwards retains it amongst the Zoantharians, because of its close resemblance to the Favositidæ, in which the presence of septa is regarded as conclusive in deciding against Alcyonarian affinity. The presence of calcareous septa, however, must now be considered a character of less importance than it formerly was. As is seen in the case of *Heliopora* pseudo-septa may exist, which do not necessarily correspond in any way, in disposition or number, with the membranous mesenteries. In the Favositidæ the septa seem to have been no more perfect than they

are in *Heliopora*, and to have been most variable in number, but often twelve, as also in *Heliopora*. Milne-Edwards describes from ten to twelve septa in *Favosites gothlandica*. In *Michelinia favosa* thirty to forty subequal septal striæ are to be made out at the upper margin of the wall of the calicle. It seems not unlikely that the septa in the Favositidæ were pseudo-septa as in *Heliopora*, and that these coralla were formed by Alcyonarians, the perforations in the walls having transmitted transverse canals of soft tissue like those of *Heliopora* and *Sarcophyton*, and the coralla being free of tubular cœnenchym, because none of the polyps were aborted as in *Heliopora*. Some Favositidæ seem to have formed a compound colony, consisting of autozooids and siphonozooids, for example, *Favosites forbesi*, in which a few large cells are seen set amongst numerous surrounding small ones. *Heliolites* seems to a certain extent to form a transition stage between a condition such as that in *Favosites forbesi* and the condition in *Heliopora*; for in *Heliolites*, the more ancient form, the cœnenchymal tubes are regularly hexagonal, and apparently much more nearly equal in breadth to the calicles than in *Heliopora*. In the growing points of *Heliopora* the hard parts are made up of a series of open often hexagonal tubes, and resemble *Favosites* in their surface aspect. In *Heliopora* the transverse canals pass over notches in the summits of the walls of the cœnenchymal tubes and calicles, in order to place these cavities in communication with one another. In *Favosites* the calcareous tissue surrounded the transverse canals, and the perforations in the walls of the calicles were thus produced.

If *Favosites* was an Alcyonarian, *Chætetes* was of course also of that group. The genus *Alveolites* amongst the Favositidæ is peculiar for the possession of three tooth-like prominences as the only representatives of septa. One tooth, well developed, is situate inside the calicle; on that side of each calicle which lies externally in the colony, and opposed to this on the tip of the calicle next the interior of the colony, are a pair of rudimentary teeth. This arrangement reminds us at once of the distinction of dorsal and ventral mesenterial interspaces in Alcyonarians, and the direction of all the "Dorsalfächer" in *Sarcophyton* and *Heliopora* towards the central axis of the colony. In *Alveolites* the two teeth seem to correspond to the "Dorsalfach," and the single one to the "Ventralfach," the two teeth having occupied the space devoid of retractor muscles. Kölliker describes a series of teeth as existing at the margin of the calicle in *Renilla*, which follow a constant law in their relation to the septa. When only one tooth is present it is opposite the "Dorsalfach;" when three, one is opposite the "Dorsalfach," and the two others opposite the lateral "Ventralfach." In *Alveolites* the one tooth is ventral instead of dorsal.

*Alliance of Syringopora with Tubipora.*—In *Syringopora* the septa seem to be very much of the same nature as in *Heliopora*; and in *Heliopora*, as already described, the tabulæ are not merely transverse floors, but the bottoms of cups of hard tissue fitted inside the older tubes and calicles. In *Syringopora* this condition of the tabulæ is much

more marked, and the corallum appears as if formed of a series of calicles fitted one within another. The discovery by Mr Charles Stewart[1] of the existence in *Tubipora musica* of infundibuliform tabulæ, which form delicate axial tubes within the larger tubes of the corallum just as in *Syringopora*, seems to prove undoubtedly that Dana, Haeckel, Zittel, and others are quite correct in placing these fossil forms in near relation with *Tubipora*. Professor Alleyne Nicholson,[2] who disagrees with the conclusions of the above-named authors, and considers *Syringopora* to be allied to the *Zoantharia perforata*, is apparently unaware of Mr Stewart's observations. He gives some account of the genus *Syringolites* (Hinde) which, though it has polygonal contiguous coralites, with mural pores like *Favosites*, has also infundibuliform tabulæ, and even axial tubes like *Syringopora*. This link closely connecting *Favosites* and *Tubipora* through *Syringopora* is a further proof of the Alcyonarian affinities of *Favosites* and its other allies.

*On the Septa of Heliopora.*—A difficulty appears to arise from the peculiar mode of the development of the calicles by budding in *Heliopora*, the foldings of the walls of the calicles being due, to a considerable extent at least, to the formation of these walls from a circle of cœnenchymal tubes. The septa are, however, not entirely formed in this way. It would of course be of great interest to see whether the primitive calicle, in the developing *Heliopora* colony, forms calcareous septa.

*Heliopora* having so commonly twelve septa, and in conjunction with these eight mesenteries, it was at first thought that here some key would be found to the elucidation of the question of the relations of the tetrameral corals to the Hexactinians; but no definite arrangement of the eight mesenteries to the twelve septa could be discovered.

*Zooids of Sarcophyton compared with those of Pennatulids.*—With regard to *Sarcophyton*, the fact that its colonies are composed of multitudes of siphonozooids, combined with a lesser number of sexual autozooids, as amongst the Pennatulidæ, was discovered by Kölliker, who failed to find such a condition existing in any other member of the Alcyonidæ or Gorgonidæ. In *Sarcophyton* and in *Heliopora* the "Dorsalfächer" are all turned towards the axes of the colonies and directed upwards, just as in Pennatulidæ. The siphonozooids in their structure seem to conform very closely to those of Pennatulids (*Sarcophyllum*, *e.g.*); but to the list of distinctive differences between the siphonozooids and autozooids of Pennatulids given by Kölliker, viz., the absence in the siphonozooids of tentacles, the presence of two mesenterial filaments (the dorsal ones), the absence of generative organs, and the shortening of the hypogastric region to such an extent that it fuses with the anastomosing canal system—to these marks of distinction must be added, in the case of the siphonozooids of *Sarcophyton*, the fact that four of the mesenteries, the dorsal and ventral pairs, are deeper than the others.

[1] C. Stewart, F.L.S., On a New Species of *Stylaster*, with a Note on *Tubipora*, Jour. of the Micro. Sci., 1879.
[2] H. Alleyne Nicholson, *l.c.*, pp. 18, 19, 214.

*Development of Alcyonarians and Zoantharians compared.*—It seems extremely difficult to reconcile the extraordinary succession of the mesenteries in the development of the Zoantharians, discovered by Lacaze-Duthiers, with the facts presented by Alcyonarians. Did the development of the eight mesenteries of Alcyonaria correspond with that of the first eight mesenteries formed in Actiniadæ, the first mesenteries formed would be either the lateral dorsal or lateral ventral; but these are those which are most rudimentary in the zooids of *Sarcophyton*. Moreover, the mesenterial filaments of the two lateral pairs of septa are in the development of Actiniadæ the first to appear, and not the dorsal, which are longest in the Alcyonarian polyps and most persistent in the zooids.

Apparently, however, development in Alcyonarians follows a different course. In *Halysceptrum*, the development of which has been examined by Kölliker, the eight mesenteries appear from the very first. In *Kalliphobe* (Busch), one of the Edwardsiæ, according to Metschnikoff, the larva has, in its earliest stage, eight tentacles and two mesenterial filaments.

# PART III.—ON THE DEEP-SEA MADREPORARIA.

## PREFACE.

A PRELIMINARY account of the Corals dredged by H.M.S. Challenger in deep water was published by me in the Proceedings of the Royal Society for 1876.[1] This Report, which related to both Madreporaria and Hydrocorallinæ, was drawn up from examination of the specimens obtained on board ship when access to very few books indeed was possible, and no named specimens in museums were available for purposes of comparison. The preliminary catalogue of Corals obtained was therefore very imperfect, and, moreover, only included a part of those dredged. The present more extended description is intended entirely to supersede the preliminary report, and includes the entire Challenger collection of deep-sea Madreporaria together with one or two shallow-water species which are not reef-building forms. Since the return of the Challenger Expedition I have been able to compare the collection of Madreporaria with the specimens in the British Museum, where every facility for my work was most readily accorded by Dr Günther. I have also had opportunity of looking through the collection of Corals in the museum at the Jardin des Plantes in Paris, and in the Natural History collection at Turin. I have further had the advice and assistance of Professor Martin Duncan, who kindly looked through the collection with me, and showed me the collection dredged by H.M.S. "Porcupine," and lent me those specimens which I needed for comparison. Moreover, through the kindness of Mr Alexander Agassiz, a duplicate set of the deep-sea Corals dredged by the American expeditions has been in my possession for constant reference, with Count Pourtalès' labels attached in all cases. Count Pourtalès himself also looked through the collection with me when on a visit to Europe about a year ago, and gave me many hints of great value. Professor G. Lindström, of Stockholm,

[1] Preliminary Report on the true Corals dredged by H.M.S. Challenger in deep water, between the dates December 30, 1872 and August 31, 1875, by H. N. Moseley, Naturalist to the Expedition (Proc. Roy. Soc. 1876, p. 544).

kindly sent me specimens of the attached variety of *Deltocyathus italicus*, and allowed me to figure one of them.

To all these naturalists I wish to express my obligations and best thanks. My thanks are also due to the late Dr F. Brüggemann, who at the time of his death was engaged in cataloguing the collection of Corals in the British Museum, and who gave me very material assistance.

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## List of Monographs and Papers in which Madreporaria occurring in the Deep Sea are described.

Pourtalès, L. F. de, Contributions to the Fauna of the Gulf Stream at Great Depths; Bull. Mus. Comp. Zool., Harvard, No. 6, Dec. 1867, *ibid.*, No. 7.

Deep-Sea Corals; Ill. Cat. Mus. Comp. Zool., Harvard, No. 4, Cambridge, Mass., 1871.

Deep-Sea Corals, Zoological Results of the "Hassler" Expedition; Ill. Cat. Mus. Comp. Zool., Harvard, No. 8, Cambridge, Mass., 1874.

Corals and Crinoids, Reports on the Dredging Operations of the U. S. Coast Survey Steamer "Blake"; Bull. Mus. Comp. Zool., Harvard, vol. v., No. 9, Dec. 1878.

Duncan, P. M., "Porcupine" Expedition, Madreporaria, Proc. Roy. Soc., 1870, vol. xviii. pp. 289–301.

A Description of the Madreporaria dredged up during the Expedition of H.M.S. "Porcupine" in 1869 and 1870, part 1; Trans. Zool. Soc. Lond., vol. viii., March 1873, part 5, p. 303.

Notices of some Deep-Sea and Littoral Corals, from the Atlantic Ocean, Caribbean, Indian, New Zealand, Persian Gulf, and Japanese, &c., Seas; Proc. Zool. Soc. Lond., 1876, p. 428.

On the Rapidity of Growth and Variability of some Madreporaria on an Atlantic Cable, with Remarks upon the Rate of Accumulation of Foraminiferal Deposits; Proc. Roy. Soc., 1877, p. 133.

A Description of the Madreporaria dredged up during the Expedition of H.M.S. "Porcupine" in 1869 and 1870, part 2; Trans. Zool. Soc. Lond., vol. x., part 5, March 1878, p. 235.

Saville Kent, W., Observations on the Madreporaria taken in the late Expedition of the yacht "Norna" off the coasts of Spain and Portugal, Ann. and Mag. Nat. Hist., 1870, vol. vi. p. 459.

Sars, G. O., On some Remarkable Forms of Animal Life from Great Depths off the Norwegian Coast. Christiania: Brøgger & Christie, 1872.

Moseley, H. N., Preliminary Report to Professor Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff, on the true Corals dredged by H.M.S. Challenger in deep water between the dates Dec. 30, 1870, and August 31, 1875. Received February 14, 1876; Read March 16. Proc. Roy. Soc. 1876, p. 544.

Lindström, G., Contributions to the Actinology of the Atlantic Ocean; Kongl. Svenska. Akad. Handl. Bd. xiv., No. 6, Stockholm, 1877.

Verrill, A. E., Notice of Recent Additions to the Marine Fauna of the Eastern Coast of North America, No 2, Brief Contributions to Zoology from the Museum of Yale College, No. 39, p. 371, 1878.

Studer, Th., Übersicht der Steinkorallen aus der Familie der Madreporaria aporosa, Eupsammina und Turbinarina welche aus der Reise S. M. S. Gazelle um die Erde gesammelt wurden; Monatsbt. der K. preuss Akad. der Wiss. zu Berlin, Nov. 1877, s. 6, 25.

## Introductory Remarks.

The number of Corals dredged by H.M.S. Challenger in deep water was comparatively few, having regard to the very large number of stations (354) at which dredging operations were conducted. No doubt this result was largely due to the fact that during all but the earlier portion of the voyage, a trawl-net with a somewhat wide mesh was made use of instead of a dredge, as yielding the best general results. The trawl made use of was an ordinary fisherman's trawl-net, with none of the improvements which Mr Alexander Agassiz has since introduced and employed with such great success in his dredgings from the United States' Coast Survey steamer "Blake."[1]

Of a great many species only a single specimen or two or three were obtained by the Challenger, but specimens of very many of these rare forms, most of which were hitherto unknown, have been since dredged by Mr Agassiz, as I am informed in a letter recently received from Count Pourtalès.

I have found considerable difficulty in assigning many of the forms obtained to species new or old. The specimens dredged were always dead when they reached the surface, and the soft parts were often more or less decomposed or battered, having suffered during the long period consumed in raising them to the surface. With the structure of the corallum only to judge by, it is very often extremely difficult, often impossible, to determine the exact affinities and relations of many forms, and in not a few instances the question at issue not only refers to the nature of the genus to which certain corals shall be referred, but even to which family a specimen shall be relegated. No naturalist who has worked at the determination of the species of corals has doubted that the classification of MM. Milne-Edwards and Haime is faulty in very many respects, and needs thorough revision. Such revision will only be possible when the anatomy of the soft parts of very many forms has been carefully worked out. Unfortunately, there are no other animals in which the technical difficulties in the investigation of the anatomy are so difficult, or in which they require so long a time for their accomplishment as in the Madreporaria. I have been able to make very few investigations of this nature, though I hope to work at the subject at leisure at some future time. The results of a few observations which I have made in the case of two or three species are given in the present memoir in connection with the descriptions of the species to which they apply.

I have placed Pourtalès' *Parasmilia variegata*, of which specimens were obtained by the Challenger, under the genus *Caryophyllia*. I cannot think that the Trochosmilidæ have any real affinity with the Astræidæ, or that the occasional presence in them of dissepiments within the interseptal chambers is of any classificatory importance. Pourtalès has found dissepiments as well developed in some undoubted *Caryophylliæ*. I believe that

[1] Bull. Mus. Comp. Zool., Harvard, No. 14, 1879, p. 292.

when the structure of the soft parts of such forms as *Caryophyllia maculata* are examined, it will be found to correspond closely with that of *Caryophyllia*, or at least show far more affinity to the Turbinolidæ than to such simple corals of undoubted alliance to the Astræidæ as those composing the genus *Antillia* for example. I have similarly neglected the fact of the presence of dissepiments in placing Professor Martin Duncan's genus *Solenosmilia* in its order in my list. It is most obviously closely allied to *Lophohelia*, and might possibly with advantage be absorbed within it. A similar bigemmation in the terminal calicles to that occurring in *Solenosmilia* may be not unfrequently observed in the case of *Lophohelia*. I conclude that the presence or absence of dissepiments is probably of no more value as a criterion for the determination of the natural affinities of various forms of Madreporaria than is the presence or absence of tabulæ amongst Cœlenterates forming a corallum.

Corals following the usual law as to early development, it necessarily occurs that nearly allied species are in the young condition very closely alike, and sometimes indistinguishable. In the very early stages the young of even widely different species of the same genus are almost absolutely alike. I have had the opportunity of noticing this to be the case, especially in some species of the genus *Flabellum*, as will be described in the sequel. In some nearly allied species of the genus, such as *Flabellum stokesi*, *Flabellum patens*, and *Flabellum australe*, the young remain alike even after they have reached a considerable size. It is only in the larger adult form that their specific distinctness becomes marked. They should not, however, for this reason be placed together on the ground of apparent gradation into one another.

No doubt some of the deep-sea corals here described may be identical specifically with certain Tertiary fossil forms, or even older species, and I have reason to believe that this may be the case with regard to more than one species of *Flabellum*; but, unfortunately, in so many instances the fossil specimens are so much obscured by the presence of matrix, or so fragmentary, that none of the finer points, on which the question of specific identity turns, can be discovered, at all events without great labour. I have, therefore, in such instances merely noted the possibility of the identity of species described with evidently allied fossil forms.

It is probable that the genera *Duncania* and *Thecocyathus* are closely related. Both have an epitheca, which grows out into hollow roots, and an internal "stereoplasma,"[1] and the columella is alike in both forms. Lindström does not place *Duncania* with the Rugosa. It is probable that the non-demarcation of the septa into groups of sixes in these genera is of itself of small importance. Pourtalès has shown from the study of the structure of *Lophophyllum proliferum* that the septa are in that coral primarily arranged in sixes. On comparing specimens of *Duncania* with those of species of *Thecocyathus*, there can scarcely be a doubt that it is most unnatural to separate widely

[1] G. Lindström Öfversigt af Vetenskabs, Akad. Förh., 1873, p. 30.

such closely similar forms, and actually place them in separate Orders with all the Oculinidæ, Astræidæ, and Eupsammidæ between them. I have no doubt that the soft structures in the two genera will, when examined, be found to be closely similar. If the Rugosa are to be maintained as a separate Order, it must be retained to include only Palæozoic forms, which differ in more important particulars. It may be that recent forms, such as *Duncania*, form a stepping-stone to the Rugose corals generally; of their close affinity with some of them there can be no doubt, when such eminent authorities as Duncan and Pourtalès agree upon the matter; but either those corals at present placed amongst the Rugosa with which they are allied must be separated from the old Order, or the Order itself must be given up as such. There can be little doubt that a system of classification which places a separation of ordinal importance between the genera *Thecocyathus* and *Duncania* must be in the highest degree unnatural. I have had no opportunity as yet of studying the structure of Palæozoic corals myself, and therefore wish to write with all due deference on the matter. Professor Martin Duncan, has expressed somewhat similar views to me on the question.

In examining specimens of *Rhizotrochus typus* in the British Museum, I was struck by the close similarity in structure displayed by its exothecal roots to those of *Duncania*. They are of the same texture on the surface, and are striated in a similar manner. Inside the calicle several thin narrow plates of hard tissue are developed running all round the calicle just within its mouth, and parallel to its wall. These seem to represent the stereoplasma. Moreover, the septa are extremely irregular, and in neither young nor older specimens is an arrangement of the septa in sixes well marked. In the oldest and largest specimen sixteen septa are thicker than the rest, and are prominent near the centre of the calicle and, so to speak, "primary." The frequent arrangement of the septa in sixteens in *Caryophyllia communis* will be found noted under the description of that species. The genus *Neohelia* described in the sequel is remarkable for having its septa arranged with perfect regularity in fives, a condition which occurs also in some forms of *Madracis*.

With regard to the distribution of the deep-sea Madreporaria, it appears that, as in the case of other deep-sea animals, they are mostly very widely distributed, indeed some, as for example *Bathyactis symmetrica*, have a world-wide range. Examples of the genus *Flabellum* appear to be rather scarce off the north-east American coast and the West Indies, and no *Flabellum* was described in Pourtalès' first list of deep-sea corals from those localities; but *Flabellum angulare* was dredged by the "Blake," and a new species of *Flabellum* was obtained by Mr A. Agassiz on his late expedition. Moreover, Mr Verrill has described another species *Flabellum goodii*, as dredged in 220 fathoms on the eastern slope of Georges Bank. At present the only genera which seem to be restricted in range are *Stephanophyllia* and *Sphenotrochus*, which have as yet been obtained only from the seas of the Malay Archipelago in comparatively shallow water,

and the genus *Leptopenus*, which has as yet been dredged only south of the equator, but both in the South Atlantic, South Indian, and South Pacific Oceans in very great depths.

No examples of any of the species of the genus *Stephanotrochus* were obtained in the Pacific Ocean They have hitherto occurred only in the Atlantic and South Indian Oceans. I have taken care to give in the description of the figures at the end of this memoir the exact locality at which each specimen figured was dredged, because local varieties may at some future time be determined, and, moreover, forms placed and named together may hereafter be separated.

The wide range in depth of some species is very remarkable, and the instance of *Bathyactis symmetrica* has often been referred to since the Challenger Expedition returned; it ranges from a depth of 70 fathoms in the tropics to one of 2900 fathoms. The following table gives the depths at which all genera of corals which have as yet been found at a depth of 50 fathoms and upwards occur. The occurrence of the genera as fossils in Secondary and Tertiary deposits is also indicated. Some shallow water forms extend to very considerable depths. The deep-sea forms are not as a whole of greater geological antiquity than shallow water forms.

TABLE *showing the Depths at which all Genera of Corals, which have as yet been obtained in Depths of* 50 *Fathoms and upwards, are known to occur.*

The depths are given in round numbers, and the ×'s indicating the ranges of the coral in depth are placed in those columns the numbers relating to which approach most nearly to the depths at which the corals have been actually dredged. Thus, if a coral has been dredged at 76 fathoms, it is marked in the 100 fathoms' column; if at 74, in the 50 fathoms' column; if at 1126, in the 1250 column; if at 1124, in that of 1000 fathoms.

| GENERA. | Depths in Fathoms at which the several Genera occur. | | | | | | | | | | | | | | | | | | | | AGE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shallow Water. | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 750 | 1000 | 1250 | 1500 | 1750 | 2000 | 2250 | 2500 | 2750 | 3000 | Secondary. | Tertiary. |
| *Caryophyllia* . | × | × | × | × | × | × | × | × | × | × | × | × | × | | | | | | | × | × |
| *Acanthocyathus* | | ? | | | × | × | × | | | | | | | | | | | | | | × |
| *Stenocyathus* . | | | × | × | × | × | × | | | | | | | | | | | | | | |
| *Paracyathus* . | × | × | × | × | × | × | × | × | × | × | | | | | | | | | | | × |
| *Leptocyathus* . | | × | × | × | × | × | × | × | × | | | | | | | | | | | | |
| *Schizocyathus* . | | | | | × | × | × | × | | | | | | | | | | | | | |
| *Deltocyathus* . | | | | × | × | × | × | × | × | × | × | × | × | × | × | × | | | | | × |
| *Trochocyathus* . | | | × | × | × | × | × | × | × | × | | | | | | | | | | × | × |
| | Shallow Water. | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 750 | 1000 | 1250 | 1500 | 1750 | 2000 | 2250 | 2500 | 2750 | 3000 | Secondary. | Tertiary. |

| Genera. | Depths in Fathoms at which the several Genera occur. | | | | | | | | | | | | | | | | | | | | Age. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shallow Water. | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 750 | 1000 | 1250 | 1500 | 1750 | 2000 | 2250 | 2500 | 2750 | 3000 | Second-ary. | Ter-tiary. |
| *Odontocyathus* . | | | | | | | | × | × | | | | | | | | | | | | |
| *Stephanotrochus* | | | | | | | | × | × | × | × | | | | | | | | | | |
| *Sabinotrochus* . | | | | | | | | | | | × | | | | | | | | | | |
| *Ceratotrochus* . | | | | | | | × | | | | | | | | | | | | | | × |
| *Conotrochus* . | | | | | | | × | | | | | | | | | | | | | | × |
| *Cyathoceras* . | | | × | × | × | × | × | × | × | × | | | | | | | | | | | |
| *Sphenotrochus* . | × | × | × | × | | | | | | | | | | | | | | | | | × |
| *Thecocyathus* . | | | × | × | × | × | × | × | | | | | | | | | | | | × | |
| *Pleurocyathus* . | | × | | | | | | | | | | | | | | | | | | | |
| *Duncania* . . | | × | × | × | × | × | × | | | | | | | | | | | | | | |
| *Haplophyllia* . | | | | | | | × | | | | | | | | | | | | | | |
| *Guynia* . . . | | | × | | | | | | | | | | | | | | | | | | |
| *Desmophyllum* . | × | × | × | × | × | × | × | × | × | × | × | × | | | | | | | | | × |
| *Flabellum* . . | × | × | × | × | × | × | × | × | × | × | × | × | × | | | | | | | | × |
| *Rhizotrochus* . | ? | × | × | × | × | × | × | | | | | | | | | | | | | | |
| *Ceratocyathus* . | | × | | | | | | | | | | | | | | | | | | | × |
| *Parasmilia* . . | | × | × | × | × | × | × | | | | | | | | | | | | | × | |
| *Caelosmilia* . . | | × | × | × | × | × | × | | | | | | | | | | | | | × | |
| *Lophosmilia* . | | | | | | | | | | | | | | | | | | | | | |
| *Cyathohelia* . | | ? | | | | | | | | × | | | | | | | | | | | |
| *Neohelia* . . | | × | | | | | | | | | | | | | | | | | | | |
| *Oculina* . . . | × | × | | | | | | | | | | | | | | | | | | | × |
| *Bathelia* . . | | | | | | | | | × | | | | | | | | | | | | |
| *Sclerohelia* . . | | | × | | | | | | | | | | | | | | | | | | |
| *Lophohelia* . . | | | × | × | × | × | × | × | × | | × ? | | | | | | | | | × | × |
| *Solenosmilia* . | | | | | | | × | × | × | × | × | | | | | | | | | | |
| *Madracis* . . | | × | × | × | × | × | × | | | | | | | | | | | | | | |
| *Axohelia* . . | | | × | × | × | × | × | × | | | | | | | | | | | | | |
| *Antillia* . . . | | × | | | | | | | | | | | | | | | | | | | × |
| *Astræa* . . . | × | × | × | × | | | | | | | | | | | | | | | | | × |
| *Cladocora* . . | × | × | | | | | | | | | | | | | | | | | | × | × |
| *Bathyactis* . . | | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × | | |
| *Diaseris* . . . | | | × | × | × | × | × | × | × | | | | | | | | | | | | |
| *Fungiacyathus* . | | | | | | | × | | | | | | | | | | | | | | |
| *Balanophyllia* . | × | × | × | × | × | × | × | × ? | | | | | | | | | | | | | × |
| *Thecopsammia* | | | × | × | × | × | × | × | × | | | | | | | | | | | | |
| *Trochopsammia* | | | | | | | | | | × | | | | | | | | | | | |
| *Dendrophyllia* | × | × | × | × | × | × | × | × | × | × | | | | | | | | | | | × |
| *Stephanophyllia* | | | × | | | | | | | | | | | | | | | | | × | × |
| *Leptopenus* . . | | | | | | | | | | | | | × | × | × | × | | | | | |
| | Shallow Water. | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 750 | 1000 | 1250 | 1500 | 1750 | 2000 | 2250 | 2500 | 2750 | 3000 | Second-ary. | Ter-tiary. |

## LIST OF ALL THE SPECIES OF MADREPORARIA DREDGED BY H.M.S. CHALLENGER IN DEEP WATER, AND OF A FEW SHALLOW WATER FORMS, TOGETHER WITH DESCRIPTIONS OF THE SPECIES, AND SOME ACCOUNT OF THE ANATOMY OF CERTAIN SPECIES.

### Family Turbinolidæ, M.-Edw. and H.

### *Caryophyllia*, Stokes.

*Caryophyllia berteriana*, Duchass.

A single perfect specimen only obtained, and fragments of a second.

Station 3. South of the Canary Islands. Lat. 25° 45′ N., long. 20° 12′ W. 1525 fathoms.

*Caryophyllia lævicostata*, n. sp. (Pl. I. fig. 1, 1*a*).

Corallum conical, attached by a long stout cylindrical pedicle, which enlarges and becomes encrusting at its base. Surface of the wall of the calicle with a polished and brightly glistening appearance. Primary and secondary costæ prominent, equally developed, with slightly sinuous edges extending from the exsert septa to the commencement of the pedicle. Tertiary and quaternary costæ marked only by faint striæ. Calicle oval, deep; septa all exsert, with coarsely granulate surfaces, the primary and secondary especially prominent with rounded upper margins in six systems and four cycles. Pali stout and prominent, slightly sinuous, with their surfaces beset with short conical projections; twelve in number opposite the tertiary septa only. Columella composed of four spirally-twisted processes.

Height 3 cm.; long diameter of calicles 24 mm.; shorter diameter 18 mm.

A single specimen only dredged, attached to a dead Stylasterid.

Station 343, off Ascension Island, 425 fathoms.

*Caryophyllia clavus*, Scacchi.

Var. *smithi*, Duncan (?).

Station 75. Off Fayal Island, Azores, 450 fathoms. All small dwarfed attached specimens.

Station 308. Off Tom Bay, Patagonia, 175 fathoms. Attached to Gorgonoid stems.

Var. *borealis*, Duncan (?). One small attached specimen.

Station 192. Off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms.

Var. *transversalis*, n. var. (Pl. I. fig. 2, 2*a*).

Wall of the calicle marked by a series of transverse, undulating, slightly prominent accretion ridges of epitheca, marking apparently a succession of intervals of rest in the growth of the calicle. Surface of the coral smooth. Costæ little marked, being obliterated by the ridges, except towards the pedicle, where they are present as numerous

fine striæ. The variety is nearly allied to var. *epithecata* of Duncan, but as all five specimens of it obtained at one locality show similar characteristics, it is here named and figured. All the specimens have a slender, short pedicle of attachment, usually slightly curved. Two are attached to dead Gasteropodous shells.

Station 192. Off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms.

Var. *epithecata*, Duncan.

One dead worn specimen only may be referred to this variety.

Station 219. Off the Admiralty Islands. Lat. 1° 50′ S., long. 146° 42′ E. 150 fathoms.

*Caryophyllia communis*, Moseley (Pl. I. figs. 4, 4*a*, 5, 5*a*).

*Ceratocyathus communis*, Seguenza.

A series of specimens of this well-marked curved form, dredged in deep water off Nova Scotia and off the Azores, are absolutely identical with specimens in the British Museum from the Sicilian Tertiaries at Messina, obtained from Seguenza, and named by him. Many of the Challenger specimens which have evidently lain for a short time on the bottom in the dead condition show a slight browning of their surface, due probably to a deposit on them of peroxide of manganese. Some of the Sicilian specimens show an exactly similar browning, and are so closely alike to the deep-sea examples that were the fossil specimens mingled with the recent it would be impossible to separate the one set from the other, except by searching for matrix in the chambers of the fossils.

All the specimens are curved and unattached. The curved pedicle is usually twisted to one side, the plane of curvature not corresponding with that of either the major or minor axis of the oval calicle. In all old specimens there is a tendency to the development of an epithecal covering around the pedicle and lower part of the wall. This epitheca appears to be composed of a dead and partly decomposed surface-layer of the corallum. In some specimens it is thick, opaque, and dull brownish-white, and covers the whole wall of the corallum nearly up to the margin of the calicle, beneath which it terminates in a sharply-defined boundary, surmounted by a zone of freshly formed semi-transparent coral substance. In the largest specimen obtained (Pl. I. fig. 4, 4*a*), the epitheca is extremely thick and conspicuous.

The majority of specimens which may be regarded as adult, being of nearly uniform size, have the calicle divided into sixteen equal chambers by as many septa, which are alike in size and form, and in the extent to which they are exsert. Each of these sixteen chambers is subdivided again by three septa, a median larger and pair of lateral smaller, into four equal smaller chambers. The sixteen larger septa would be termed primary and secondary, according to ordinary nomenclature, but they are precisely equal in development. There are sixteen well-developed pali opposite the septa of the next order,

or the tertiary (Pl. I. fig. 5 *a*). In some specimens there are fourteen major septa and chambers only, and fourteen pali. In the only very large specimen obtained (Pl. I. fig. 4 *a*), which is somewhat broken, there appear to have been twenty-four pali, with a corresponding development of the septa, which however are a little irregular. In one young specimen, measuring 12 mm. in height, and 10 mm. in longer diameter of the calicle, there are twelve pali, and the major chambers show evidence of having been twelve originally, but two of them contiguous to one another at one end of the long axis of the calicle have developed additional septa so as to appear as four major chambers; in these, however, pali are wanting opposite the so-called tertiary septa. Two of their septa which have taken upon themselves, by the subdivision, the rank of primary or secondary septa, have nevertheless opposite them still each a palus. As the coral widens in growth, and these new septa of first order assume their full dimensions, no doubt their pali become lost to view, and partly fused with the columella mass, partly incorporated in the growing septa. Two new pali must be developed in front of the two new tertiary septa to make up the fourteen, and in the young specimen now under consideration a trace of one such new palus has commenced to grow in front of one of the four septa. The accompanying diagram will explain the mode of multiplication of the chambers and septa. The major septa are marked *a*, those of secondary size or the tertiary *b*, the new major and tertiary septa *a′* and *b′* respectively, the pali *p*, and the

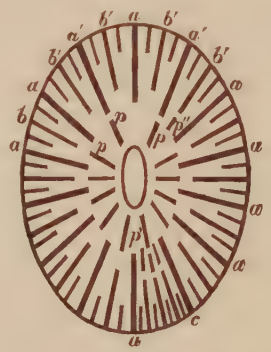


Diagram showing the mode of development of new septa and pali in *Caryophyllia communis*.

new palus *p″*. The new chambers develop in this coral in the same manner therefore as in *Flabellum irregulare* as described by Semper,[1] that is to say, the additions to the septa take place in the chambers at the ends of the longer axis of the calicle. It would seem probable that in some instances a pair of extra-major chambers develop, as in the young specimen first described, only at one end of the oval calicle; hence are derived the specimens with fourteen pali. In other instances, probably, a pair of additional

[1] C. Semper, Ueber Generationswechsel bei Steinkorallen und über das M. Edwards' sche Wachsthumsgesetz der Polypen. Zeitsch. für Wiss. Zool., Bd. xxii., 1872, s. 243.

major chambers is developed at each end of the major axis of the calicle, and hence the more abundant specimens with sixteen pali. In one specimen with fourteen fully-developed pali and major chambers, the two end chambers at one end of the long axis are in the process of dividing each into two. The chambers have as yet not enlarged much in width, and their additional septa are crowded together, but curiously enough a pair of new pali is already developed in each of them opposite the new tertiary septa, just external to the old pali in each case, which thus look at first sight as if they had bifurcated at their outer ends. On one side between the two small new pali an additional minute palus has been abnormally developed on the original tertiary septum, which thus bears two pali. This condition is shown in the diagram on one side at *c*, where p′ refers to the original palus which appears externally to split into three.

A further addition of two pairs of chambers, at either end of a calicle, would produce in instances of unusually prolonged growth, a coral with twenty-four major chambers and pali. It is quite possible that they arise in this way. The large specimen figured in Plate I. fig. 4*a*, is a little irregular, two of the chambers being not quite perfect and symmetrical; but it appears to have had thus twenty-four pali and major chambers. In two very small dwarfed, or young specimens, apparently to be referred to this coral, which were dredged off Bermuda, in 690 fathoms, there are twelve pali, and the septa show a regular symmetrical arrangement in twelves. It is of great interest that the fully-developed coral appears to arrive most usually at an arrangement in fours. Two of Professor Martin Duncan's figures ("Porcupine" Madreporaria, part 1, pl. xlviii. figs. 8 and 10), of *Caryophyllia clavus*, and var. *elongata*, show distinctly sixteen pali and sixteen major chambers.

In the large specimen referred to above, the inner borders of all the major septa curve in pairs, deep within the calicle, towards one another, to fuse with the lateral surfaces of the palus situate between each pair, and becoming thus united with the pali they cease at some distance from the columella, whilst the pali are continued on to fuse with the columella as very stout laminæ.

There seems to be no reason for separating this coral from the genus *Caryophyllia*, and it is therefore here retained in it. Professor Martin Duncan has already absorbed the genus *Ceratocyathus* within *Caryophyllia* ("Porcupine" Madreporaria, part 1, pp. 305, 314).

Extreme height of the largest specimen, not allowing for the curve, 30 mm. Long diameter of the calicle 31 mm. Height of average specimen 20 mm. Height of young specimen, with twelve pali and fourteen major chambers, 14 mm.

Station 50. Off Nova Scotia, lat. 42° 8′ N., long. 63° 39′ W. 1250 fathoms. Numerous fully grown specimens.

Station 78. Off the Azores, lat. 37° 24′ N., long. 25° 13′ W. 1000 fathoms. Numerous fully grown specimens.

Station 57. Off Bermuda. 690 fathoms. Two small dead specimens only.

Station 45. Off New York, lat. 38° 34′ N., long. 72° 10′ W. 1240 fathoms. One dead and broken specimen only.

Station 142. Off the Cape of Good Hope, lat. 35° 4′ S., long. 18° 37′ E. 150 fathoms. One dead broken specimen only.

*Caryophyllia cylindracea*, Reuss (?).

*Caryophyllia cylindracea*, Duncan, "Porcupine" Madreporaria, part 1, p. 315, pl. xl. figs. 5–8.

A single much broken specimen obtained is possibly referable to the above species.

Station 33. Off Bermuda, 435 fathoms.

*Caryophyllia paucipalata*, n. sp. (Pl. I. figs. 3, 3*a*).

Corallum conical and straight, attached by a somewhat broad base. Outer surface smooth, but not glistening, without epitheca, but marked to its base by very fine and delicate slightly sinuous costal ridges and striæ. Calicle circular, septa very slightly exsert. In the only perfect specimen the calicle is divided into ten equal major chambers, which are each again divided by septa of two orders into four sub-chambers. There are thus forty septa in all. There are five small rod-like pali only, and a central columella closely like any one of the pali in structure and appearance. In another specimen, perfect except that it has lost the columella and pali, a similar primary division of the calicle into ten is plainly indicated, but two contiguous major chambers are larger than the others, and each has two extra septa developed next to the major septa, which bound their sides furthest from one another. An incomplete additional pair of major chambers is thus formed, and an approach to hexradiate symmetry is made. It is remarkable that in both specimens dredged together a marked arrangement in tens should be exhibited.

Height of corallum 16 mm. and 12 mm. Diameters of calicles 10 mm. and 9 mm.

Station 24. Off Culebra Island, Danish West Indies. 390 fathoms. Two specimens only obtained.

*Caryophyllia profunda*, n. sp. (Pl. I. figs. 6, 6*a*, 6*b*).

Corallum elongate, cylindrical, expanded gradually towards the calicular end, attached by a stout and broad expanding and encrusting base. Surface towards the calicular end glistening, very finely granulate towards the base, usually enveloped in an abundant, dense, dull white epitheca. Costæ fine, and little prominent, only the primary and secondary forming projecting ridges, present only at the calicular end of the corallum, obliterated beneath by epitheca. Calicle elliptical, with a deep fossa; septa exsert, with rounded margins, of four sizes, with well developed pali opposite the tertiaries. Septa and pali very variable in number, but four septa always present to each palus. Out of fifteen large specimens five have twenty-one pali, five twenty, two twenty-three, one twenty-four, one nineteen, and one seventeen.

This species is very near to *Caryophyllia clavus*, but differs from it in having fewer costæ, and these more delicate and not all equally prominent, and also in the abundant epitheca developed around the base.

All the specimens obtained were fused together into masses, composed of eight or ten coralla, united by the abundant encrusting epitheca which in places spreads over and partly conceals old dead calicles forming parts of the masses.

The corals were obtained in the living condition, and observed expanded in sea water. They varied much in colour. In the largest specimen obtained, which is that on the extreme right in fig. 6, Plate I., and the calicle of which is shown in fig. 6, *a*, the disc was of a transparent bluish colour, so transparent that the pali were visible through it. Near the margin of the calicle the disc was of a sulphur-yellow colour. The margin of the mouth was white, and was thrown into a number of folds or plaits, of which twenty-two were counted on one side. Other specimens adhering to the same mass had their transparent discs marked with burnt-sienna coloured streaks in place of the yellow, and one of these had the margin of the mouth vermilion coloured, instead of white, as had also another which was streaked with yellow, like the largest specimen. The tentacles were all short and conical, each with a red knob at the tip. Each septum had a single tentacle placed at its inner margin. The tentacles were thus disposed at successively further distances from the axis of the coral, and decreased correspondingly in dimensions, being of four sizes.

Extreme height of the longest specimen 47 mm. Long diameter of the calicle 27 mm. Shorter diameter 23 mm.

Station 135, off Nightingale Island, of the Tristan da Cunha group, 100 to 150 fathoms; abundance of specimens.

A fragment possibly referable to this species was dredged with *Corallium rubrum*, off St Jago Island, Cape Verde group, in 100 to 120 fathoms.

*Caryophyllia maculata*, Pourt. (Pl. IV. figs. 8, *a*, 9, *a*).

*Bathycyathus maculatus*, Pourtalès, Ill. Cat. Mus., Harvard, No. 8, p. 34, pl. vi. figs. 5, 6.
*Parasmilia variegata*, Pourtalès, Ill. Cat. Mus., Harvard, No. 4, p. 21, pl. i. fig. 13.
*Bathycyathus elegans*, Stüder, Monatsbericht der K. P. Akad. der Wiss., Nov. 1877, s. 628, pl. i. figs. 1, *a–d*.

Professor Stüder described his *Bathycyathus elegans* in ignorance of Pourtalès' *Bathycyathus maculatus*, which appears to be identical with it, and takes precedence. I see no reason to separate *Bathycyathus* from *Caryophyllia*, because of the smallness of the pali, or the superior exsertness of the quinary septa. The whole aspect of the present coral when grown under favourable conditions is that of a *Caryophyllia*. I have therefore placed the species in that genus. Pourtalès' *Parasmilia variegata* seems certainly to be inseparable from *Bathycyathus*, and, most probably, both from the

description he gives of it and his figure, to be referable to the present species. In his description the corallum is said to be of "irregular shape, resulting from the young being originally attached to fragments of the parent which become gradually covered over and incorporated by the base;" "the costæ distinct to the base, and fine granulated;" "the septa of the third order lowest of all;" "the primary and secondary septa coloured of a dark purple, which colour continues some distance down the corresponding costæ;" "the young bud out of the calicle, which is split in consequence." All of these peculiarities apply also to *Bathycyathus maculatus*, as described and figured by the same author, and as may be seen in the present Challenger specimens. Moreover, in some of the Challenger specimens (fig. 8, *a*), which are undoubtedly from Pourtalès' photographic figure identical with *Bathycyathus maculatus*, the tertiary costæ are most prominent, and in some there is a coloured spot on each of the quaternary costæ below the border of the calicle, peculiarities also cited by Count Pourtalès as occurring in *Parasmilia variegata*. It is further stated that the presence of dissepiments was not observed in this latter coral.

The specimen here figured (fig. 9, *a*) is exceptionally large and evenly grown, being attached to a Gorgonoid stem. The primary and secondary costæ are prominent near the margin of the calicle, are there coloured brown, as are also the exsert parts of the corresponding septa. A few of the tertiary septa are tipped with brown, and there is a brown dot on one or two of the quaternary costæ. The pali are more than usually well developed, as also the columella, which is composed of a mass of twisted and contorted coral matter continuous with the inner margins of the septa. The amount of coloration of the septa seems to vary widely in this species, as might be expected, but the presence of dark brown pigment tinging some septa and costæ and not others is characteristic of it.

Station 170. Off the Kermadec Islands. 630 fathoms. One specimen only.

Station 122. Off Barra Grande, Brazil. 400 fathoms. Five specimens.

*Caryophyllia lamellifera*, n. sp. (Pl. I. fig. 7, *a–b*).

The corallum is cylindro-conical, attached by a stout pedicle, which is dilated and encrusted at the base. The whole is in the adult compressed and slightly curved. It is of a brown colour, both in the adult and young. The entire outer surface of the corallum is covered with a series of delicate but sharply-cut projecting ridges or lamellæ formed of epithecal substance, which give it the appearance of the cutting surface of a file. The lamellæ, which are sharp-edged, are separated by sulci, which are of about three times their own width. They course parallel to one another horizontally around the surface of the corallum, and the several ridges extend for long distances, branching, or joining contiguous ridges only at long intervals. Some ridges probably extend entirely round the pedicle and cup of the corallum. The ridges are of hard and glistening coral substance; they are continued over the costæ, which are but little prominent, and on the outer edges

of the exsert septa there are small notches indicating a direct continuation of the ridges on them. The ridges are, unfortunately, not properly drawn in the plate, but an idea of their appearance will be obtained from fig. 8*b*, Plate I., which shows their form in a closely allied species. The calicle is oval in outline : in the single adult specimen obtained the septa are disposed hexradiately and quite symmetrically. There are six systems of septa and four complete cycles. The septa are all exsert, the primary being more prominent than the secondary. The tertiary and quaternary septa are little prominent, the latter more so than the former. The surfaces of all the septa in their upper regions are covered with abundant rounded granules disposed in rows; these in the depths of the calicle appear as small, stout, tooth-like projections which nearly block up the cavities of the chambers. The primary and secondary septa are straight, but the inner edges of the tertiary and quaternary are slightly sinuous. There are twelve pali opposite the tertiary septa : they are in the form of small, sinuous laminæ. The columella is large and oval, composed of numerous small, sinuous lamellæ.

Attached to the adult specimen is a young one, in which the calicle is not yet compressed, but is nearly hexagonal in outline. It has six systems of septa and three complete cycles. The secondary septa are much smaller than the primary, and have in front of them six pali. Their inner margins are sinuous. The faces of the septa are thickly beset with projections in the deeper parts of the calicle. The ridges are as well marked on the surface of the young as on the adult coral.

The file-like surface of this coral is very peculiar, and is characteristic of it and the next species. I had some thoughts of making a new genus to contain the two species, but there seem hardly sufficient grounds to separate the present one from *Caryophyllia* in the absence of information concerning the soft structures.

Extreme height of the adult specimen, 12 mm. Breadth of the calicle, 7 mm. Height of the young specimen, 4 mm. Breadth of the calicle, 2·5 mm. One adult specimen only with a young one attached to it.

Station 170. Off the Kermadec Islands. 630 fathoms.

*Caryophyllia rugosa*, n. sp. (Pl. I. fig. 8, *a–b*).

The corallum is small, of a light brown colour, short and cylindrical in form, attached by a broad, encrusting base. In some specimens the corallum is slightly wider towards the calicular end, and not simply cylindrical, as in the specimen figured; in some young specimens the upper part of the columella is conical, being considerably narrowed above the commencement of the expanded base. The surface of the corallum is marked with a series of horizontal ridges, just as in the foregoing species *Caryophyllia lamellifera*, but the individual ridges are in the present species shorter (fig. 8*b*). In a vertical section of the corallum, the folds or plaits of the wall composing the ridges are seen to be marked by a peculiar texture of the coral substance or epitheca, far into the thickness of the wall.

The calicle is circular in outline, the septa are only very slightly exsert. The septa in the larger specimens are arranged symmetrically in multiples of eight in three cycles, There are eight primary septa, eight secondary, and sixteen tertiary, of successively smaller size. Opposite the secondary septa are eight pali. In one small specimen there are either fourteen or fifteen primary and secondary septa, and either seven or eight pali. In another small one there are sixteen primary and secondary septa, but only seven pali, there being a gap in the circle of pali opposite one of the secondary septa; but in another, almost equally small, there are eight well-developed pali. On rubbing down the base of this specimen in order to expose the earliest formed septa, I found these rather irregular when first brought into view by the section, but as soon as cut into so far as to be distinctly marked, showing plainly as eight in number—nowhere as six : I could only afford to cut one specimen. All the septa are thin and delicate laminæ, with nearly smooth surfaces. They are remarkably sinuous throughout their extent, and especially so towards their inner margins. They arise from the inner wall of the calicle along sinuous lines, so that when a vertical section of the corallum is made, the septa exposed

Diagram showing a vertical section of *Caryophyllia rugosa*.

nearest the line of section are cut through at a succession of intervals at their projecting folds, and hence the section shows a series of chambers, one above another, separated by sinuous transverse lines of coral substance.

The columella is composed of small, sinuous, lamellar processes, which are nine in number in the largest specimen ; four, five, and three in the smaller ones respectively.

This species is retained as a *Caryophyllia*, notwithstanding the octameral arrangement of its septa, because it is most evidently from its general appearance, peculiar colour, and file-like external surface, closely allied to *Caryophyllia lamellifera*. It is distinguished from this latter species by its octameral arrangement, the peculiar sinuosity of its septa, and the smoothness of their surfaces, and also in the adult condition by its simple cylindrical form.

Height of the largest specimen, 4 mm. Breadth of the calicle, 4 mm. Height of the smallest specimen 2 mm. Breadth of the calicle 2 mm.

Six specimens attached to small stones.

Station 192. Off the Ki Islands. 126 fathoms.
One specimen (?) referred at the time to the same species, but lost.
Station 201. Basilan Straits, Philippine Islands. 102 fathoms.

### *Acanthocyathus.*

*Acanthocyathus dentatus*, Moseley (Pl. II. fig. 7, 7*a*, 7*b*, 7*c*).

*Acanthocyathus dentatus*, Moseley, Proc. Roy. Soc., 1876, p. 550.

The corallum is white, and in the form of a much compressed cone; the outlines of its broader faces form a nearly equilateral triangle. It is attached by a very small pedicle. The surface of the corallum is roughened by small granulations all over. The primary and secondary costæ on the two faces of the corallum project as prominent thin laminæ in its upper region, and are continued down to the very base of the pedicle as fine ridges. The two primary costæ forming the lateral angles of the corallum are more prominent than the others and form lateral wings. In the only specimen obtained, one lateral wing is much more fully developed than the other. The one least developed is only slightly notched at its margin, but the larger one is excavated so as to project in the form of four prominent teeth. The calicle is elongate-oval in outline, with the ends of the oval slightly angular. There are six systems of septa and four complete cycles; the septa are all exsert—the primary and secondary prominently so—the quaternary septa lying next the primary are higher than the tertiary, and are fused externally to the sides of the former. There are twelve pali opposite the tertiary septa; the inner margins of the septa and the pali are delicately sinuous. The surfaces of the septa are sparsely covered with small pointed granules. The columella is elongate, and composed of three delicate spirally-twisted laminæ.

This species differs from *Acanthocyathus grayi* (Edwards and Haime[1]) and *Acanthocyathus spiniger* (Kent[2]) in being white, and in the less development of its species. From *Acanthocythus grayi* it differs in being attached, and in being lighter and more delicate.

Extreme height of the specimen 14 mm. Long diameter of the calicle, exclusive of the wings, 11 mm. Shorter diameter 8 mm. A single specimen only obtained.

Station 174. Off Kandavu Island, Fiji group. 210 fathoms.

*Acanthocyathus spinicarens*, n. sp. (Pl. II. fig. 6, 6*a*, 6*b*, 6*c*).

The corallum is of a reddish-brown colour, and has the form of a compressed cone, the outline of which is that of a nearly equilateral triangle. The surface of the corallum is roughened all over by the presence of thickly-set, small, rounded granulations, and hence appears dull and not at all polished. It is attached by a small pedicle, and is very

[1] MM. Milne-Edwards et J. Haime, Hist. Nat. des Coralliaires, t. ii. p. 22.
[2] W. S. Kent on New Madrepores, Proc. Zool. Soc. 1878, p. 275.

slightly bent in the plane of compression. Near the margin of the calicle all the costæ are well marked as slightly prominent thick ridges with rounded edges. The primary and secondary costæ extend on one face of the corallum nearly to the base of the pedicle; on the other face, where they are less marked, they cease somewhat higher up. The tertiary and quaternary costæ are much less developed than the others, and are well marked only close to the calicle; beneath they are indicated only by slight separating striæ. The two lateral primary costæ are thickened and prominent, but much less so than in other species of the genus; their edges are notched here and there irregularly; the outline of the calicle is oval, very slightly angular at the ends of the oval. There are six systems of septa and four cycles; twelve pali opposite the tertiaries. All the septa are exsert; the exsert quaternaries are all higher than the tertiaries, and are fused externally to the side of the primaries and secondaries. The septa are straight, and their faces are almost smooth, being very sparsely covered with extremely minute spinules. The columella is elongate, and composed of thin twisted lamellæ.

The coral resembles *Acanthocyathus grayi* and *Acanthocyathus spiniger* in colour, and though the lateral spines are represented in it only by little developed laminæ, there can be no doubt that it falls naturally within the genus *Acanthocyathus*. From *Acanthocyathus grayi* it differs in the more marked exsertness of its septa, and in these being slighter and smoother, also in the greater extent of the costæ, further in the dulness of its surface, the surface in *Acanthocyathus grayi* being smooth and glistening. It resembles *Acanthocyathus spiniger* in the exsertness of its septa, but differs from it in being bent, and in the very small development of its alæ, also in having the costæ less sharply ridged, and only the primary and secondary at all prominent.

Height of the corallum 17 mm. Long diameter of the calicle 18 mm., exclusive of the alæ. Short diameter 13 mm. A single specimen only obtained.

Station 210. Off the Philippine Islands, lat. 9° 26′ N., long. 123° 45′ E. 375 fathoms.

### *Paracyathus.*

*Paracyathus de filippii* (Duch. and Mich.).

Pourtalès, Ill. Cat. Mus. Harvard, No. 8, p. 38.
*Paracyathus confertus*, Pourtalès, Ill. Cat. Mus. Harvard, No. 4, p. 11.

Numerous specimens. Off Fayal Island, Azores. 50 fathoms.

One specimen. Station 190. Arafura Sea. Lat. 8° 56′ S., long. 136° 5′ E. 49 fathoms.

### *Heterocyathus.*

*Heterocyathus philippinensis*, Semper.[1]

Numerous specimens. Off Malanipa Island, Southern Philippine Islands. 20 fathoms.

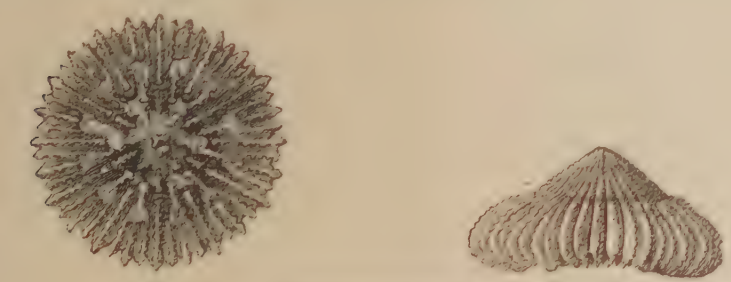
[1] Ueber Generationswechsel bei Steinkorallen, Z. f. Wiss. Zool., Bd. xxii., 1872, s. 254.

MM. Milne-Edwards and Haime formed a genus *Stephanoseris* for a coral investing a shell with its base, found at Zanzibar, which they had previously placed in the genus *Heterocyathus*. They removed the species *S. rousseaui* from the genus *Heterocyathus* and the Turbinolidæ, and placed it far apart with *Fungia:* because of the presence in it of synapticulæ. There can, however, be no doubt from the exact resemblance in structure of the septa and pali that the true affinities of the coral are with *Heterocyathus*, and that the synapticulæ must be considered as of minor importance. The species *rousseaui* should therefore be restored to the genus *Heterocyathus*. For a description of the genus *Stephanoseris*, and references to Milne-Edwards' and Haimes' papers on the subject (see Hist. Nat. des Coralliaires, tom. iii. p. 56).

## *Deltocyathus.*

### *Deltocyathus italicus*, Milne-Edwards and Haime.

*Deltocyathus italicus*, M.-Edw. and H., Pourtalès' Ill. Cat. Mus., Harvard, No. 4, p. 15, pl. xi. figs. 1–5, pl. v. figs. 9, 10; *Ibid.*, No. 7, p. 35, pl. vi. fig. 11; G. Lindström, Actinology of the Atlantic Ocean, Bd. xiv., No. 6, s. 10, pls. i. ii. figs. 13–20.



*Deltocyathus italicus* (× 4).

*Deltocyathus italicus* (× 3). Stellate variety of Pourtalès.

I have little to add to the very full accounts of the many varieties of the above species contained in the memoirs cited, and in Pourtalès' later notes on the subject in the Bull. Mus. Comp. Zool., Harvard, vol. v. No. 9, p. 200. After comparing our series of specimens, which is very small in comparison with that at the disposal of Pourtalès,

with specimens of *Deltocyathus italicus*, kindly given to me for the purpose by Count Salvadori, of Turin, I considered that Pourtalès was quite justified in maintaining *Deltocyathus agassizi* as a separate species, on the grounds of the structure of the costæ; but I have, at the moment that this memoir is going to press, learned by a letter from Count Pourtalès that he has been led, by the examination of a long series of specimens dredged this year by Mr Agassiz, to the conclusion that the specific claims of *Deltocyathus agassizi* cannot be upheld, and that he intends to adopt for the American form the old name, as Professor Martin Duncan had already done. I have, therefore, done so also.

I give here woodcuts of the more usual form of the species, and of Pourtalès' variety *calcar*, from drawings by Mr J. J. Wild.

Although the series obtained near St Thomas, Danish West Indies, appeared to bear out Pourtalès' assertion that the young coralla of this species are cup-shaped, and that they gradually become more saucer-shaped as age advances, such is not the case in a long series of fifty specimens dredged off the Azores. In this nearly all the larger specimens have the calicle deeply cup-shaped, whilst the younger ones are flatter, and some of the very small ones (2·5 mm. in diameter) absolutely flat. Some of the specimens are 14 mm. in diameter, a shade larger than Pourtalès' largest specimen. The series presents points of well-marked variation from the West Indian specimens. The coralla are all characterised by having their primary and secondary septa, as well as their pali, extremely exsert; but the pali never project so high as the septa to which they are soldered at their bases, as they do in Pourtalès' specimens and in those dredged by the Challenger in the West Indies. No tendency towards the development of the horned variety described by Pourtalès is to be seen in the series obtained off the Azores, although Professor Lindström remarks on an approach to the variety *calcar* in some of his East Atlantic specimens, as shown in them by an excessive development of the primary costæ. It is remarkable that only one specimen of the horned variety was obtained by us, and that (the one figured) merely by accident, in the cup of a sounding machine off Bermuda. It is further very remarkable that none of the specimens obtained by us were attached, and that only one shows any trace of ever having been attached. This one specimen, however, is large, and though somewhat imperfect has a most distinct pedicle and scar of attachment, and evidently remained fixed up to a period of full maturity. It is figured on Plate II. figs. 2, 2*a*, 2*b*. Since, singularly enough, none of Count Pourtalès' specimens were attached, or showed traces of attachment, I figure (Pl. II. figs. 3, 3*a*) a specimen, one of two kindly sent to me for examination by Professor Lindström, and dredged off the Danish West Indies in from 200 to 320 fathoms. There can be no doubt as to the identity of this specimen with *D. agassizi*.

After comparing Professor Martin Duncan's specimen of *Sabinotrochus apertus* with the series of *Deltocyathus*, I conclude that Professor Lindström's conjecture that it is a

variety of *Deltocyathus agassizi* cannot be upheld. *Sabinotrochus* differs in its general texture, and in the thickness of its septa, in its fine wavy costæ, and in the margin of its calicle being indented, also in the complete absence of pali, which are certainly not broken away. In all my specimens of *Deltocyathus italicus* there are pali, or remnants of them. *Sabinotrochus* seems rather nearly allied to *Stephanotrochus*. After decalcification of specimens of this species hardened in absolute alcohol, an external film of soft tissue separates from the outer surface of the wall, but only from that region of it near the mouth of the calicle; all the region near the tip of the cone is devoid entirely of living tissue.

One specimen of a coral, which is in a semifossilised condition, embedded partially in a hard black clay, and much decomposed, appears referable to *Deltocyathus agassizi*. If so, it is of remarkably large size, measuring 18 mm. in diameter.

Station 78, off the Azores. 1000 fathoms. Fifty specimens.

Station 56, off Bermuda. 1075 fathoms. Several specimens.

Station 120, off Pernambuco, Brazil. 675 fathoms.

Station 24, off Culebra Island, Danish West Indies. 390 fathoms.

Station 285. Attached variety. One specimen. South Pacific Ocean. Lat. 32° 36′ S., long. 137° 43′ W. 2375 fathoms.

Off Bermuda. 200 fathoms. Var. *calcar*. One specimen only brought up in a sounding machine.

Station 191, between the Aru and Ki Islands. 800 fathoms. Very large dead specimen of this species (?).

*Deltocyathus magnificus*, Moseley (Pl. IV. fig. 10, Pl. XIII. figs. 1, 2).

*Deltocyathus magnificus*, Moseley, Proc. Roy. Soc., 1876, p. 662.

In this gigantic species of the genus the corallum is quite flattened and discoid. The inferior surface is slightly concave, the margin of the calicle being somewhat tumid owing to the prominence of the costæ. The tissue composing the corallum is dense, and of a slight reddish-yellow not white as in *Deltocyathus agassizi*. On the under surface the wall is smooth, but shows a few concentric rings of growth and a slight conical elevation in the centre which points to the coral having been cup-shaped in the very young condition. The costæ are all nearly equally developed; they commence in succession in the centre of the inferior surface or near to it as fine lines composed of very minute granules, and begin to rise from the surface as fine projecting laminæ only towards the outer half of the surface; towards the margin they are very prominent with rounded ridges, and being all of equal prominence give the margin a tumid appearance. On close inspection the primary and secondary costal laminæ can be seen to be slightly thicker than the tertiary quaternary and quinary which are closely alike. There are six systems and five complete

cycles of septa. The septa are remarkably symmetrical in their arrangement. The quinary septa unite over the quaternary. All the septa bear paliform lobes, those of the quaternary being the largest and those of the quinary indistinctly marked. The paliform lobes are marked on the primaries only by slight notches in the edges of these septa. The faces of the septa are covered sparsely with very fine sharp granules. The columella is elongate in form and diffuse, spreading over the apices of the deltas formed by the fused tertiary septa. It is porous and spongy in texture, but yet of compact tissue, and with a comparatively even surface. In the structure of the columella the species differs markedly from the other species of the genus.

The disc of the living animal was of a light ochre-yellow colour, somewhat reddened towards the margin. The tentacles were white.

Diameter of the single specimen 30 mm.

Two closely similar specimens were obtained at the same haul, but one was unaccountably lost, and the one figured only now remains.

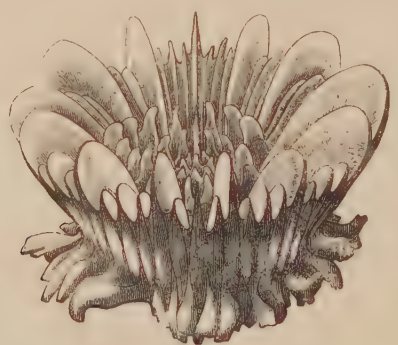
Station 192. Off the Ki Islands. 129 fathoms.

### *Odontocyathus*, n. gen.

Corallum with a fascicular columella and three crowns of pali, free but with a minute scar of former attachment, in the form of a deep saucer, with straight sloping sides and a broad flat base composed of fused radiating tuberculate spines which project like the spokes of a wheel all round the base of the wall.

*Odontocyathus coronatus*, Moseley (Pl. II. fig. 4, 4*a*, 4*b*; 5, 5*a*, 5*b*).

*Trochocyathus coronatus*, Pourtalès, Ill. Cat. Mus., Harvard, No. 4, p. 14, pl. vi. fig. 16; Moseley, Proc. Roy. Soc., 1876, p. 550.



*Odontocyathus coronatus* (× 2).

The corallum is white. It is free, but with a small scar of adherence. It is circular in horizontal section, with a broad flat base, with the plane of which the walls of the calicle, sloping outwards, make an angle of about 60°. At its junction with the wall

of the calicle, the base is continued horizontally outwards into twelve stout spines, irregularly beset with small pointed tubercles. The spines correspond in position with the primary and secondary costæ. There are six systems of septa, and four cycles, with a partial fifth cycle in large specimens. The septa of the four cycles are complete. All the septa are exsert. The primary, secondary, and tertiary septa bear pali, those of the tertiary septa being the most developed. The columella is large and composed of a tubercular mass of contorted papillæ.

A young and imperfect specimen of this coral was figured and described by Pourtalès as *Trochocyathus coronatus*. One of the young specimens obtained by the Challenger shows the identity of the forms. The young differs very much from the adult, the spines being scarcely at all developed. The adult form is so peculiar in its shape as to require the formation of a new genus for its reception. In its tendency to develop a fifth cycle of septa, the species conforms with the *Trochocyathi armés* of MM. Milne-Edwards and Haime, a large number of these having five cycles.

Station 24, off St Thomas, Danish West Indies. 390 fathoms. Five specimens obtained at one haul.

Count Pourtalès' specimen was brought up by the lead from 460 fathoms, in lat. 30° 41′ N., long. 77° 3′ W., off the coast of Florida.

Since the coral is peculiar and interesting, I give here a fully detailed description of the specimens obtained, all of which were dead when brought up.

### Detailed Description of the Corallum of *Odontocyathus coronatus*.

The corallum is white. It is free and circular in horizontal section with a broad flat base, with the plane of which the walls of the calicle sloping outwards make an angle of about 60°. At its junction with the wall of the calicle the base is continued horizontally outwards into twelve stout pointed tubercles or spines irregularly beset with small pointed projections, these tubercles corresponding in position with the primary and secondary costæ. The base has thus, when viewed from beneath, an irregularly circular outline with deep indentions at its margin. In the centre of the base is a conical projection, at the summit of which is a very small somewhat oval clean-cut surface, the trace of adherence of the corallum. From the base of the conical projection proceed twelve radiating ridges, one to each of the basal tubercles, becoming more marked as they proceed outwards. These ridges are beset with small pointed tubercles which, with the ridges themselves, increase in size from the centre outwards. These small tubercles are arranged to some extent at regular intervals along the ridges, and there are traces of a series of concentric wavy lines corresponding in position to the several sets of tubercles. These are, evidently, lines of growth showing the outline of the base of the corallum at successive stages, the tubercles corresponding to each of these lines having been originally

marginal, but having become nearly obliterated by fusion with other tubercles successively formed outside them, and sometimes entirely lost in the resulting ridge. In one specimen a second series of very delicate ridges is clearly marked radiating outwards for a short distance from the base of the central cone and corresponding with the tertiary and quaternary costæ. The whole surface of the base of the corallum is covered with small rounded closely apposed granules. The large marginal tubercles of the base are from 4 to 5 mm. long, and about 4 mm. broad at their origin from the base. Superiorly they are joined by slightly elevated rounded ridges, the continuations into them of the primary and secondary costæ. The majority of the tubercles are tapering but some are obtuse. They terminate in three or four irregularly disposed spines. Two or even three marginal tubercles are sometimes fused together laterally into one mass.

From the region of origin of the marginal tubercles the wall of the calicle slopes outwards at an angle of about 60° with the plane of the base, its height above the plane being about 14 mm. The rounded ridges described as passing into the bases of the marginal tubercles reach upwards to the margin of the calicle. The external edges of the exsert primary and secondary septa are continued downwards along the middle of these costal ridges for about one-third the height of the wall of the calicle. The tertiary and quaternary costæ are present as much smaller ridges, separated by fine vertical striæ. The calicle is somewhat constricted at the region of attachment of the marginal spines, hence its lateral outline is not linear but curved slightly at a short distance from its inferior origin. The whole surface of the wall of the calicle is scattered over with small pointed granulations.

The calicle, which is circular in outline, is shallow. The arrangement of the septa is irregular in the two smaller specimens, which are of the size of the one described by Pourtalès: there are six systems and four cycles. In the other three larger specimens, in several of the large interseptal spaces, included between the primary and secondary septa, two septa are developed in addition to the usual three. In the largest specimen these additional septa are present in five of the twelve larger interseptal spaces, in another in six. In one intermediate in size between the two last mentioned, the primary and secondary septa combined are thirteen in number, and one of the larger interseptal spaces only has additional septa developed in it. There is thus a tendency in this species to develop a fifth cycle of septa. A large number of the *Trochocyathi armés* of Milne-Edwards and Haime are provided with five cycles of septa. The septa are complete with the exception of those of the fourth and partial fifth cycle. The primary and secondary septa are very prominently exsert, projecting 4 mm. vertically above the margin of the wall of the calicle. Their edges are rounded, and they slope gradually downwards to the spot where the pali take origin. The tertiary and quaternary septa are also exsert, but in a much less degree. The tertiary septa occasionally coalesce with the primary or secondary. The primary, secondary, and tertiary septa are provided with pali which form three circlets. The pali

are very conspicuous and prominent, those of the third cycle being as usual the largest and projecting to a height of 4 mm. above the level of the summit of the columella, whilst those of the primary cycle are not elevated more than 1·5 mm. above that point. The tertiary pali are broad, the secondary and primary much narrower. The superior margins of all the pali are rounded. In some specimens all the pali are slightly indented on their inner edges. The pali of the secondary septa are placed at a slightly further distance outwards from the centre of the columella than those of the primary. The pali thus form three rings or crowns. Wherever a pair of septa of the partial fifth cycle are developed, the quaternary septa intervening between them are greatly enlarged, and occasionally fused with the adjoining tertiary septa. They are also provided with pali somewhat smaller than those of the tertiary cycle, and placed at a slightly further distance from the axis of the coral. The whole of the septa and pali are formed of thin but strong laminæ slightly thickened at the line of origin from the calicle, and terminating superiorly in sharp knife-edged margins. The surfaces of the septa and pali are covered with very small granular projections, which on the primary and secondary septa are seen to be arranged with considerable regularity in rows, radiating from a point a little inferior to the point of junction of the septa with the margin of the calicle towards the margin of the septa, and marking out also a series of successive lines which follow the course of the margins of the septa, and are the lines of growth of the septa. Similar lines of growth are to be observed on the pali. The columella is about 4 mm. in breadth, and is composed of a number of contorted papillæ covered with a fine granulation, and more or less fused into a single tubercular mass in old specimens.

Diameter of calicle of smallest specimen 15 mm. Height, exclusive of conical tubercle on base, 8 mm. Diameter of calicle in largest specimen 27 mm. Extreme diameter of the same measured from the outer edges of the summits of the exsert septa 32 mm. Height of calicle 16 mm.; measured to the top of the septa 20 mm. Diameter of base of calicle 21 mm., of circlet of basal spines 28 mm.

### *Stephanotrochus*, n. gen.

Corallum dense and compact in substance, cup-shaped or saucer-shaped, with trace of early attachment, usually with well developed costæ bearing a succession of small spines, with widely open capacious fossa. Septa usually extremely exsert, the exsert quinaries, or quaternaries where these are not present, lying next to the primaries, higher than the tertiaries, or equal to them. Columella absent or little prominent.

I have formed this genus to contain four species of corals dredged by the Challenger which are evidently very closely allied, but for which it is nevertheless somewhat difficult to find generic characteristics in the terms of the ordinary designation of genera. I placed the four species provisionally in my Report on Corals in the genus *Ceratotrochus*.

*Stephanotrochus diadema*, Moseley (Pl. III. fig. 1, *a–c*).

*Ceratotrochus diadema*, Moseley, Proc. Roy. Soc., 1876, p. 553.

The corallum is white and saucer-shaped. The central region of the base is flattened and nearly horizontal, the lateral portion of the wall rises with some abruptness from this horizontal region at an angle of about 55° with the vertical. A very short rudimentary pedicle is seen in the centre of the base and terminates in a small scar of adherence.

*Stephanotrochus diadema.* (Once and a half the natural size.)

From the base of the pedicle radiate out well-marked costal ridges corresponding to the primary and secondary septa. These ridges are sharp and serrate, the dentations being inclined towards the margin of the calix. The primary costa are more prominent than the secondary, and take origin nearer the peduncle. Tertiary costæ are present as only slightly elevated narrow untoothed ridges, most marked near the margin of the calyx; the quaternary costa are very faintly marked. There are six systems of septa and five cycles. The whole of the septa are exsert, the primary and secondary extremely so, projecting nearly a centimeter above the margin of the calicle; the quinary septa next to the primary and secondary are higher than the quaternary and equal in height to the tertiary, in some instances even higher than these latter; they are joined for nearly their entire height to the primary and secondary septa by prolongations of the wall. The quinary septa next the tertiaries are lower than the quaternaries. The primary, secondary, and tertiary septa are remarkably stout and straight, and rise above the level of the remaining septa within the calicle. The septa are irregularly denticulate on their edges, and covered with granules arranged in curved lines of growth; the upper terminations of the exsert septa are rounded. The free borders of the primary, secondary, and tertiary septa in their curved sweep towards the columella each present a shallow notch, corresponding in position to the region where the somewhat abrupt change from horizontal to inclined contour in the base of the corallum occurs. Beyond this notch the border of each septum rises again slightly, an indistinct indication of a paliform lobe being thus formed; the primary septa are entirely free from adhesion with others, and are thereby conspicuous; the tertiary septa are fused to the secondary close to the columella; the quaternary unite with the tertiary

bending in towards them for the purpose at points somewhat further outwards; the quinary unite with the quaternary at a point still further distant, a condition thus exists which is like that in *Deltocyathus* and some *Stephanophyllias*. The disposition of the septa is remarkably uniform in all the systems; the columella is composed of contorted finely fascicular matter, it is large and low, flat surfaced, and oval in superficial outline.

A mutilated specimen of what is apparently the young of the same species was obtained on another occasion with the soft parts attached. The disc at the margin of the calicle between the exsert septa was of a dark madder colour, and the same colour was extended on the membrane, stretching thence over the base to the region where the costal spines commence. Beyond this region the outer wall of the corallum was bare and not invested by living tissue. The remainder of the disc was of a pale bluish tint with a zone of intensely dark madder colour round the mouth. The young corallum is thinner in texture, and flatter, and with the septa little exsert.

Extreme diameters of the calicles 47·5 mm. and 30 mm. respectively. Extreme breadth between the exsert tips of the septa, 57·5 mm. and 36 mm. Vertical height of the larger specimen to the margin of the calicle, 47·5 mm.; to the summits of the highest septa, 21·5 mm.

One large perfect specimen dredged at Station 120, off Pernambuco, Brazil. 675 fathoms.

Mutilated young specimen. Station 78, off the Azores. 1009 fathoms.

*Stephanotrochus discoides*, Moseley (Pl. III., fig. 2, 2*a*, 2*b*, 2*c*).

*Ceratotrochus discoides*, Moseley, Proc. Roy. Soc., 1876, p. 554.

The corallam is white and is saucer-shaped, but much flatter than in *Stephanotrochus diadema*; there is a short pedicle and small scar of attachment. The primary and secondary costæ only are prominent, and bear each four or five short spines; the primary and secondary septa only are exsert, and these do not rise high above the margin of the calicle. There are six systems, and only four cycles. The septa of the fourth cycle being only partially developed in many of the systems, only two instead of four quaternaries being present in most of the systems, and these being those lying between the primary and tertiary septa. These quaternary septa are bent towards the tertiaries to fuse with them. The free borders of the septa are nearly straight, showing only an extremely slight indentation indicative of the paliform lobe seen in *Stephanotrochus diadema*. All the septa except the quaternaries run straight towards the centre of the calicle. Their inner ends are thickened and dilated, and, fusing together with the addition of some diffuse cementing calcareous matter, form a sort of columella, the surface of which is excavated in the very centre of the calicle by a well marked pit.

From the denseness of its calcareous tissue and its general appearance, this Coral

appears to be adult, and though closely allied to the last species to be distinct from it specifically although it was obtained at the same time.

Diameter of the single specimen, 12 mm.

Station 120. Off Pernambuco, Brazil. 675 fathoms.

*Stephanotrochus platypus*, Moseley (Pl. III. figs. 4, 4*a*, 4*b*; 5, 5*a*).

*Ceratotrochus platypus*, Moseley, Proc. Roy. Soc., 1876, p. 554.

The only two specimens obtained are of a dull opaque white colour, and had evidently lain dead on the sea-bottom for a long time. The corallum is circular with a horizontal base, from which the low wall rises abruptly and almost vertically. In the larger of the two specimens there is no trace of a peduncle, but the remains of a spiral gasteropodous shell are to be seen embedded in the coral tissue. In the smaller specimen an indication of a peduncle is to be seen arising also from a spiral shell, which is in this instance not deeply embedded as in the other. In the larger specimen the base is almost flat, but somewhat irregular in surface; in the smaller it is hollowed out around the point of attachment; the costæ are simple slight rounded ridges continued from the centre of the base to the margin of the calicle, only the primary and secondary are well marked; there are no costal teeth or spines. There are six systems of septa and five cycles; the quinary septa are incomplete, and also many of the quaternary; no lateral fusion of septa occurs; the septa are all straight. The primary septa are continued to the very centre of the calicle and there meet in a point; the secondary are continued nearly as far, and there is no columella properly so called, merely a very small amount of hard tissue present, soldering the adjacent inner ends of the septa laterally. The primary and secondary septa are exsert to an extraordinary degree, rising far above the margin of the calicle, and terminating with nearly horizontal edges; the primary septa are considerably higher than the secondary. The tertiary and quaternary septa rise only just above the margin of the calicle, but the quinary septa next the primaries rise very high and are fused to them externally by continuations of the wall; the quinaries next the secondaries are also high and similarly fused to these latter but do not rise quite so high as those next the primaries. Curved rows of granules are present on the septal faces as in *Stephanotrochus diadema*, marking lines of growth. The free margins of the principal septa are much curved, in the smaller specimen bent nearly at a right angle. On these margins, in the case of some of the septa of the larger specimen, a slight indication of a paliform elevation is visible.

Extreme diameters of the calicles in the two specimens respectively, 46 mm. and 35 mm. Heights of the walls above the horizontal planes of the bases, 8 mm. and 6 mm. Height to the summits of the primary septa, 22 mm. and 19 mm.

Station 164. Off Sydney, New South Wales. 410 fathoms.

*Stephanotrochus nobilis*, Moseley (Pl. III. figs. 3, *a*, *b*).

*Ceratotrochus nobilis*, Moseley, Proc. Roy. Soc., 1876, p. 554.

The corallum is white, and is deep and cup-shaped. There is a short curved peduncle at the centre of the base, with a small scar of attachment. An area round the peduncle representing the bottom of the cup is roughened by concentric ridges and toothed costæ; beyond this area the wall of the calicle is smooth, and the costæ devoid of teeth. The smooth area is that which in the recent state of the Coral is covered with a living membrane reflected from the margin of the calicle; the roughened area, which is also somewhat discoloured, is in the recent state of the coral bare of living tissue. The teeth on the costæ

*Stephanotrochus nobilis* (Moseley). Slightly enlarged.

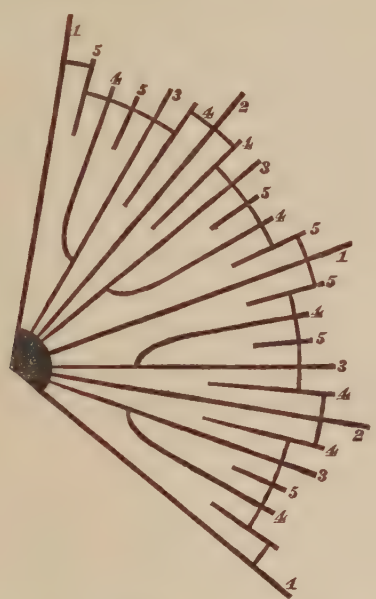


Diagram showing the arrangement of the septa in *Stephanotrochus nobilis*, and the relative extents to which the various septa are exsert and joined to one another. The septa of the various orders are denoted by numbers.

are probably produced in succession as the calciferous membrane is withdrawn from the apex of the base to successively greater distances as growth proceeds. Only the primary and secondary costæ are well marked. They are, within the discoloured area, beset with small denticulations, just as in *Stephanotrochus diadema* and *Stephanotrochus discoides*. At the verge of the area they almost disappear, but rise again towards the margin of the calicle, as smooth-edged thick laminæ, which are directly continuous with the exsert septa. There are six systems and five cycles. The primary and secondary septa are equal, and are prominently exsert, with rounded upper margins. The free margins of the septa are at first nearly vertical, then curve gradually inwards towards the base of the calicle, the fossa is thus remarkably deep and widely open; there are indications of paliform lobes on

all the septa except the quinaries, most marked on the tertiaries, very faint on the others. As in *Stephanotrochus discoides*, only one pair of quaternary septa is well developed in size in each system, and these are the quaternaries next the primaries, and they are bent towards the tertiaries to fuse with them; the two being nearly equal in size divide each half-system into three nearly equal sections, the tertiary being, as it were, out of place somewhat. The other pair of quaternaries in each system is small, looking like a large quinary, and between it and the adjacent secondary the quinary septa are absent; there are only four quinaries developed in each system instead of eight. The quinaries next the primaries rise as high in exsertion as the tertiaries, and are joined to the primaries by prolongation of the wall; to the secondaries are fused the exsert tips of the little developed quaternaries next them, which rise to the same height also as the tertiaries. The arrangement of the septa is shown in the preceding diagram.

The tertiary, secondary, and primary septa extended nearly to the centre of the bottom of the fossa; their ends here are fused together, and connected in the centre by a very small quantity of tortuous calcareous matter, the only representative of a columella. The coral bears some resemblance to *Turbinolia obæsa*, Michelotti[1] (*Trochocyathus obæsus*, M.-Edw. and H.), as figured, but the details available are not sufficient to determine if the two forms have any real alliance. In *Trochocyathus obæsus* the pali are well developed.

Height of the single specimen, to the margin of the calicle, 25 mm.; to the lips of the primary septa, 33 mm. Extreme breadth of the calicle, 33 mm.

Station 73. Off the Azores. 1000 fathoms.

### *Cyathoceras*, n. gen.

Corallum conical, elongate, without epitheca, or with a partial one only, fixed by a stout pedicle, with a well developed fascicular columella.

This genus is formed to receive two species which might be placed with *Desmophyllum* if they had not columellas in every respect resembling those of the *Caryophyllias*.

*Cyathoceras cornu*, n. sp. (Pl. IV. figs. 7, 7*a*).

Corallum elongate, conical, attached by a stout base, with a few transverse irregular constrictions or ridge-like marks at intervals, looking as if formed by a partial spontaneous fracture and reuniting of the coral, or as marking succession of intervals in growth. Costæ slightly marked near the margin of the calicle only. Surface slightly roughened, or covered to a considerable extent with a thin glistening transparent epitheca. Calicle circular. Septa in six systems and four complete cycles, somewhat irregular, free from attachment to one another, barely exsert, straight, except at the inner margins where they are sinuous, with nearly smooth surfaces. Columella prominent in the fossa of the calicle, slightly elongate, composed of four or five twisted laminæ.

[1] Description des terraines Miocenes de l'Italie septemtrionale, Leide, 1847, p. 22, pl. i. figs. 21, 22.

Height of the coralla, 15 mm. and 22 mm. respectively. Diameters of the calicles, 10 mm. and 12 mm.

Station 320, off the mouth of the Rio de la Plata. 600 fathoms. One specimen.

Station 163, off Twofold Bay, New South Wales. 120 fathoms. One specimen.

*Cyathoceras rubescens*, n. sp. (Pl. II. fig. 8, 8*a*, 8*b*, 8*c*).

Corallum of a very pale reddish tint, white in places, elongate conical, curved, much compressed in its upper part, with a cylindrical stout pedicle terminating in an expanded and encrusting base. Surface glistening but slightly roughened. Costæ more marked on one face than on the other, little prominent, except just at the margin of the calicle where all the exsert septa are continued a very short distance down the wall. Septa all exsert, with rounded edges; the quinary higher than the quarternary, and joined for nearly their entire height externally to the adjacent primaries, secondaries, and tertiaries, those next the tertiaries not so high as those next septa of higher order. Calicle elliptical in outline, with a deep fossa. Septa in six systems and five cycles, one pair of systems being incomplete in the only specimen. Septa free from attachment to one another, straight, with smooth surfaces, and slightly sinuous inner margins. Columella elongate in form, prominent in the fossa, composed of numerous more or less spirally twisted thin laminæ.

Height of the corallum, 35 mm. Breadth of the calicle, 23 mm.

One perfect specimen, only attached to a dead fragment of another.

Station 192, off the Ki Islands. 129 fathoms.

### *Sphenotrochus.*

*Sphenotrochus rubescens*, Moseley (Pl. VI. fig. 8, 8*a*).

*Platytrochus rubescens*, Moseley, Proc. Roy. Soc., 1876, p. 553.

The corallum is of a light red colour. It is compressed and wedge-shaped, without trace of adherence, and provided with lateral aliform expansions derived from the lateral costæ. The surface of the wall is roughened all over by the costæ or their prolongations, and on the alæ by transverse ridges. The whole of these ridges and costæ are covered with minute sharp granules, so that the entire surface of the coral feels rough to the touch, like fine sand-paper. The costæ commence as the continuations of the borders of the exsert septa, and are there prominent thin laminæ. They gradually decrease in elevation towards the base, where they appear as small narrow ridges, which are somewhat confused and interrupted here and there, though all converging in direction towards the apex of the coral cup. The primary and secondary costæ are near the margin of the calicle, somewhat thicker than the others, but otherwise all the costæ are equally developed and of an even height, except the two lateral ones, in three out of four specimens procured. In the fourth specimen the primary and secondary costæ are a

good deal more prominent than the others. The lateral costæ are developed in the lower region of the corallum into aliform projections, which vary much in their width. In the specimen figured they are less developed than in any of the others procured; they are usually broader towards the base of the corallum. In some specimens their edges are more or less notched; their surfaces are covered by a series of ridges like those formed by the costæ near the apex of the corallum. The ridges are directed at right angles to the line of slope of the coral cup, and are parallel, but here and there irregular; in some places the costal ridges, where they abut on the lines of origin of the alæ, are seen to be bent outwards to join the ridges on them. The outline of the calicle is oval, the fossa is extremely deep, and the whole interior of the calicle open and hollow to the apex, not being filled up by any outgrowths of the septa or columella. The septa are all perfectly straight, with smooth surfaces dotted over with very minute rounded granules and showing curved accretion lines. The primary and secondary septa are equal. All the septa are exsert, the tertiary and quaternary according to their order. There are four cycles of septa and twelve primary and secondary septa, and evidently there must be in the young coral primarily six systems, but in all four specimens the two pairs of lateral chambers at the ends of the long axes of the calicles have developed two additional septa, a tertiary and a quarternary in each, so that there are four additional imperfect systems in each coral, which correspond exactly in all the specimens (see fig. 8*a*).

The columella is elongate in form, and remarkably slender and prominent, composed of four or five small columns of roughened calcareous matter partially fused together laterally. It projects up free from the bottom of the fossa formed by the excavated edges of the primary and secondary costæ for a height of 5 mm. At the bottom of the fossa these septa fuse with its base, and it is directly continued below as a narrow lamina perpendicular to the apex of the corallum, being free from any of the additional irregular calcareous outgrowth which is usually developed about the base of the columella and the inner ends of the septa in many other corals.

After comparing this coral with specimens of *Sphenotrochus crispus*, I conclude that it must necessarily be placed in the same genus. It differs from the other *Sphenotrochi* in the considerable exsertness of the septa, and in having four cycles of septa instead of three, also in the great depth of the fossa; but these differences are probably due to the large size of this recent species, in all essential particulars it is closely allied to *Sphenotrochus crispus*. That species differs from it mainly in its smaller size, in having its costæ much larger in proportion, in having its septa denticulate, and in possessing a much shallower fossa; in the peculiar form of its columella it closely corresponds with *Sphenotrochus rubescens*. *Sphenotrochus auritus* (Pourtalès[1]) has a flat protuberance on either side of the base, but these flat expansions are very different from the aliform appendages of the present species.

[1] Hassler Expedition, *loc. cit.*, p. 37.

Colour of the animal greenish-yellow, the mouth margin white, with twelve broad glistening white folds or bands, disc external to these emerald green. As far as I can determine from the mutilated specimen, I believe that this coral differs from others which I have examined in that in the contracted state all the tentacles are concealed, the disc contracting and closing in over them as in *Actinia*. In the contracted animal there is a sphincter-like opening in the centre of the disc, which leads to a cavity in which are the tentacles, out of which again opens the mouth which is surrounded by a prominent ridge. The entire outer surface of the corallum is invested by a thin lamina of living tissue. Johnston observed the living British species *Sphenotrochus macandrewanus*, and has given some description of it.[1]

Extreme heights of three coralla 19 mm., 17 mm., and 17 mm., respectively. Extreme breadth of the calicles 20 mm. in all the specimens. Shorter diameters of the calicles 16 mm. to 13 mm. Extreme breadth of the alæ in one specimen 3 mm. Breadth at the base of the corallum between the outer edges of the alæ in the above specimen, 16 mm.

One perfect fresh specimen was obtained, and another which had the soft parts present but had been badly crushed in the dredge, with these were two dead and partly broken specimens.

Station 192, off the Ki Islands. 129 fathoms.

### *Pleurocyathus*, n. gen.

Corallum conical, attached by its side. Entirely covered by a thin plicated coloured bark-like epitheca, which rises higher than the margin of the calicle. Wall of the calicle very thin, except near the margin, where a zone of stereoplasma is developed, soldering together the outer regions of the septa where they arise from the wall. The lower part of the calicle devoid of stereoplasma or other filling. The columella composed of several flattened pillars.

The coral, for which this genus is formed, is evidently nearly allied to *Duncania*,[2] but differs in its much thinner epitheca, in the restriction of the stereoplasma to the marginal region, in the absence of paliform lobes to the septa, and in the hexagonal arrangement of the septa being comparatively little obscured. Lindström found in a thin section of the apex of a *Duncania* six septa of the first order distinctly marked.[3]

*Pleurocyathus brunneus*, n. sp. (Pl. II. fig. 1, *a–c*).

The corallum is in the form of a short straight cone. It is attached by a broad adherent surface situate on one side near the apex. The external surface is covered with a rough brown epitheca which is extremely thin and has a pellicular appearance.

[1] British Zoophytes, 2d ed., 1846, p. 196. [2] Pourtalès, Ill. Cat. Mus., Harvard, No. 8, p. 45.
[3] Actinology of the Atlantic, p. 13.

The epitheca is marked at intervals by several horizontal folds or ridges, and in its upper region is thrown into a series of longitudinal costal folds which are equally developed and only very slightly prominent. In some parts of the wall they are marked on the lower part of the corallum also, being traceable nearly to the apex. Towards the edge of the calicle the epitheca shows a triple margin appearing as if produced by three intervals in growth. The rounded edges of the primary and secondary septa can just be seen above the level of the margin of the calicle, which is nearly circular in outline. The sexradiate arrangement of the septa is a little obscured by irregularities, but can be plainly made out. There are six systems and four cycles, with additional septa in three pairs of the systems. The additional septa are developed symmetrically in pairs as regards the longer transverse axis of the calicle, but not as regards the opposite ends of that axis. The septa are quite straight with smooth faces; their inner edges are straight and perpendicular and parallel to the face of the columella, which they join only at a considerable depth within the calicle by curving horizontally inwards just as occurs in *Sphenotrochus rubescens*, with which coral the present agrees also in the form of the columella. At the margin of the calicle at a little distance below the edge of the epithecal border, and at a short distance below their own outer summits, the outer regions of all the septa are soldered together by a zone of stereoplasma (the name by which Lindström[1] denotes the solid calcareous matter filling up the interior of such corals as this and *Duncania*) which extends down for about one-third of the height of the calicle. The lower part of the calicle is quite free from stereoplasma or other filling up, but hollow to the apex, and the wall of the lower part is so thin as to be translucent when held up to the light. The columella is somewhat elongate in the outline of its summit, indicating thus the position of the longer transverse axis of the calicle. It is composed of four vertical flattened pillars fused together below but free at their tips. It projects up free within the fossa for a height of 2 mm.

Height of the calicle, 8 mm. Diameter of the calicle, 6 mm.

One specimen only dredged, attached to a fragment of volcanic rock.

Station 194. Off Banda Island, East Indies. 60 fathoms.

### *Desmophyllum.*

*Desmophyllum ingens*, n. sp. (Pl. IV. figs. 1–6, 1*a*–6*a*, Pl. V. figs. 1–to 4, 1*a*–4*a*).

In the fjords of Western Patagonia were dredged numerous specimens of a gigantic *Desmophyllum* which seems closely allied to *Desmophyllum crista galli*, but which, because of its extraordinary size, and because an exactly similar coral occurs in Sicilian Tertiary beds, I have termed *Desmophyllum ingens*. Various forms of the coralla are figured on Plate V. of the natural size. The coralla are extremely massive and heavy. The shapes are exceedingly various according, to some extent, to the positions in which the

[1] Actinology of the Atlantic, p. 13.

coralla grow attached. The short cylindrical forms with expanded summits (figs. 2 and 3), were attached to large Gorgonoid fans, and all the specimens so attached were more or less alike. The compressed trumpet-shaped specimens with long attenuated and branching bases (figs. 1 and 4, Pl. V.) are mostly attached to one another, and often form large and complicated masses as in the specimen figured in fig. 4, which is reduced to one-half the natural size. The outer surfaces of the coralla are smooth and covered with an abundant dense epitheca, which solders them to one another or to any objects with which they are in contact, and, as may be seen in fig. 1, Plate V., occasionally fills up the interseptal chambers of dead specimens with solid heavy calcareous matter. In the largest specimens there are five complete systems of septa which are almost exactly regular. The septa are extremely thick and stout, and from their free margins at the base of the fossa, in the largest specimens, grow out large rounded knob-like projections forming a sort of columella as in *Flabellum*.

A series of young specimens is figured on Plate IV. showing the various stages of growth. The smallest specimen (fig. 2) has six systems and four complete cycles, and the margin of the calicle is nearly even, being only slightly toothed by the primary costæ, which alone are exsert. In the next specimen (fig. 3) there are still only four cycles, but all the septa are slightly exsert, and the quaternary septa next the primaries and secondaries are higher than the tertiaries, and lie close against the principal septa. In some cases the septa do not become exsert until the coral is much larger, as is seen in the case of the specimen shown in figure 1, where the septa are as yet not at all exsert, although quinary septa are already developed in this instance in some of the systems. The specimen shown in figure 6 has already assumed the form of the larger compressed specimens. In it the fifth cycle is complete in all the systems, whilst the quinary septa next the primaries and secondaries are in most of the systems as high as these latter septa, and are joined to them for their whole height by a prolongation of the wall.

There is a fossil specimen in the British Museum collection from quaternary beds at Messina, marked *Anthophyllum*, n. sp., which is identical apparently with the larger compressed trumpet-shaped specimens from Patagonia, both in form and dimensions. In the Jardin des Plantes' museum there is a specimen of *Desmophyllum crista-galli*, from Cape Breton, which resembles the Magellan specimens very much, but is smaller.

Professor Martin Duncan has also shown me a fragment of a *Desmophyllum*, dredged from 904 fathoms in the Mediterranean, which indicates a calicle almost as large as those of the Magellan Straits' specimens. The fragment is blackened with manganese.

Long diameter of the calicle of the largest specimens, 82 mm. Short diameter, 50 mm. Extreme length of longest specimen, 135 mm.

Numerous specimens dredged in the fjords of Western Patagonia.

Station 306. 345 fathoms.

Station 307, off Saumarez Island. 147 fathoms.

Station 308, off Tom Bay. 175 fathoms.
Station 311. 245 fathoms.

*Desmophyllum eburneum*, n. sp. (Pl. VI. figs. 1, 1*a*, 1*b*).

Only imperfect specimens of this species were obtained. The corallum is of a pure white. It is elongate conical in form, slightly compressed, with a long cylindrical pedicle which expands slightly at the broad base of attachment. The outer surface of the corallum is remarkably smooth and polished, and glistens like polished ivory. The primary, and in some specimens also the secondary costæ appear on the surface, where the corallum begins to expand, as slightly prominent ridges, here and there roughened by slight indentations. The development of the costæ varies much in different specimens, as also the amount of exsertion of the septa. The primary septa are prominently exsert and sometimes unequally so, and some are bent over outwards beyond the margin of the calicle. In some specimens the secondary costæ are as far exsert as the primary; the tertiaries are only slightly exsert. There are six systems of septa and four complete cycles. The septa are straight and thin, and are covered on their faces with sparsely scattered, small-pointed granules. Only the primary and secondary septa extend to meet one another laterally around the centre of the calicle, where their perpendicular margins surround a deep but narrow fossa.

Judging from the broken specimens, the height of the full-grown calicles is probably about 35 mm. Extreme breadth of a perfect calicle, 21 mm.

Station 306. Off Middle Island, Patagonia. 345 fathoms.

*Desmophyllum cailleti*, Duch. and Mich.

*Desmophyllum cailleti*, Duch. and Mich., Supp. Mém. Coral, 1874.

A single dead and partly decayed specimen obtained off the Virgin Islands appears referable to this species; if so, it is large, measuring 30 mm. in height, and 20 in diameter of the calicle.

Station 24. Off Culebra Island, Danish West Indies. 390 fathoms.

## *Flabellum*, Lesson.

### Notes on the Structure of the Soft Parts of Species of the Genus *Flabellum*.

When a specimen of a *Flabellum* hardened in absolute alchohol is decalcified, no trace of any external layer of soft tissue covering the outer surface of the wall remains. The living tissues in *Flabellum* are confined to the interior of the calicle and the immediate outer edge of its margin. The decalcified mass of soft tissue which occupied the interior of the calicle, consists of twelve wedge-shaped lobes connected together at their narrowest ends by means of the central stomach of the animal. The interior of each of the lobes

opens immediately into the stomach by a single aperture, but just within the aperture the cavity of the lobe is divided into two, and again subdivided into four, and in large *Flabellums*, such as *Flabellum alabastrum*, again into eight. The lobe is similarly subdivided externally by a series of deep fissures, regularly disposed in pairs, in which, before decalcification, lay the calcareous septa.

Between the lobes and between their subdivisions are slit-like openings by which the chambers containing the septa communicate with the stomach cavity.

In all simple Madreporarian corals which I have decalcified, the mass of soft tissues resulting from the operation is divided into twelve primary lobes attached to the stomach. Hence there are in these only twelve pairs of complete mesenteries, and the remaining mesenteries are less and less complete in successive order. In *Actinia* there are many more complete mesenteries than this number.

The muscles of the mesenteries are inserted into the corallum along the lines of junction of the septa to the wall, or between these, and with great firmness, so that when the corallum is broken away small pieces of it hang tenaciously to the muscular shreds. The muscles are always on the sides of the mesenteries next the septa, and the chambers containing septa never contain mesenterial filaments unless when one of these, more than usually large, takes a few coils on the opposite side of the mesentery from that on which lies its main expanse. Towards the bottom of the calicle the muscles, as seen in transverse sections of the hardened coral, shift outwards, to be inserted eventually as long slips into the corallum ; and here the generative organs take the places of the mesenterial filaments.

The muscles are inserted only at the outer margins of the mesenteries to the corallum (unless possibly also to the columella). The muscular fibres are disposed amongst branching offsets of the median mesodermal plates of the mesenteries, which spring from the surfaces of these plates, standing out vertically from them, just as in *Sagartia* as described by Heider.[1]

In *Flabellum alabastrum* each mesentery has a sort of arch of muscular fibres, specially concentrated at its border, near its outer lower margin. Below the arch hang folds of the border of the mesentery thickly set with contorted filaments (Pl. XIV. fig. 11). A corkscrew-like mass of the filaments usually depends just below the muscular arch. Corresponding to the two faces of the twelve primary and secondary septa, twenty-four straight, ridge-like folds hang down the stomach-wall, and are continued below into thick filament-bearing borders. From these ridges spring the lower borders of the primary and secondary mesenteries, and the filaments on the borders are coiled on the faces of these mesenteries which are turned away from the septa. At the top of each stomach-slit, between these twenty-four folds, spring the borders of the tertiary mesenteries, which

[1] A. v. Heider, Sagartia Trogodytes (Gosse), Ein Beitrag zur Anatomie der Actinien Sitztz. der k. Akad. der Wiss. Wien, Bd. lxxv., 1877, s. 41, taf. vi. fig. 43.

are smaller, and have no directly depending ridges and filaments, but which, diverging a little, course outwards, with slight contortion of their borders, to form, after a short distance, dense masses of coils on the faces of the mesenteries. The borders of the quaternary mesenteries and filaments arise from the under surface of the disc membrane still further out, and hence their filament tissue does not touch that of the stomach anywhere; they pass out, as do the foregoing, and are similarly distributed. Processes of the muscles of the septa are prolonged into the tentacles, and near the borders of the mesenteries, where the tentacles arise, strong transverse fibres are developed in the mesenteries, which, when traced upwards, are seen to belong to the same system as the circular muscles of the tentacles. The tentacles, when cut across in decalcified sections, show the two laminæ which invested on either side the septa over which they are placed, crossing their bases. The tertiary mesenteries sometimes in *Flabellum alabastrum* bear a few ova, sometimes not. The ova developed on primary and secondary mesenteries are abundant in the deep chambers in the apex of the corallum, and also those of the tertiary, which also pass far down. The sexes are distinct in all the specimens of *Flabellum* which I have dissected. The male elements are enclosed in the mesenterial masses, just like the ova, and apparently fill up all the lower chambers of the corallum solidly.

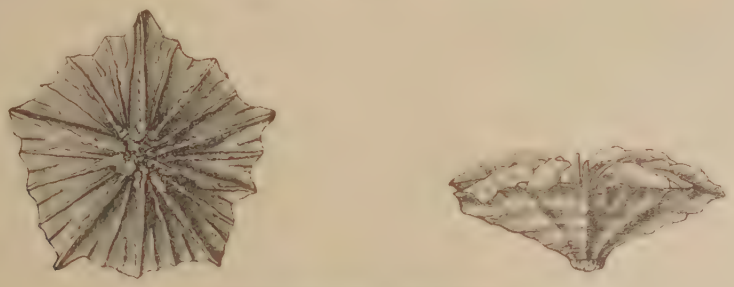
In *Flabellum japonicum* there are dark pigmented glands in the ectoderm, as in *Sagartia*. The ova commence just below the muscular arch of the mesentery, and behind the dependent spiral coil of mesenterial filament. The coverings of soft tissue on the faces of the septa are excessively thin, and consist of simple endoderm and mesoderm, never having muscles in their substance or anything like mesenterial filaments attached to them. They are evidently foldings up of the lining membranes of the interseptal chambers raised up from the wall. In each fold is developed a septum. In the corallum the septa themselves are seen in the lower part to look like folds.

A diagrammatic representation of the arrangement of the mesenteries and septa, and of the disposition of the layers of tissue composing them is given on Plate XVI. fig. 10. The ideal transverse section which it represents is supposed to be taken at the level of the margin of the corallum so as to pass just below the soft tissue membrane composing the disc. Hence soft tissues are represented as occurring on the outside of the corallum. The section, further, is taken above the level at which the chambers between the mesenteries open into the stomach. The mesenterial muscles are placed on the sides of the mesodermal plates of the mesenteries which lie next the septa, whilst the mesenterial filaments lie on the opposite sides of these.

One tentacle in section is introduced into the diagram in order to show the relation of the tentacle to the septum lying beneath it and to its investing layers.

*Flabellum angulare*, Moseley (Proc. Roy. Soc., 1876, p. 556). (Pl. VI. figs. 2, 2*a*, 2*b*.) The corallum is thin and fragile, and of a pearly white, covered externally with a

glistening pellicular epitheca. The calicle is vase-shaped, widely open, the diverging walls making with one another an angle of about 110°. A short cylindrical pedicle is present. The mouth of the calicle is even and pentagonal in outline in the single specimen; from each angle of the pentagon a stout costal ridge, very slightly dentate, runs down to the pedicle. Between these costæ the wall of the calicle presents five faces almost flat, but with slightly marked secondary costæ. The septa are in five systems and four cycles; they consist of extremely fragile laminæ covered with granules



*Flabellum angulare.* Natural size.

on their faces. The septa are complete, except the quaternary, which reach to a very short distance from the calicular margin. The columella is well developed and trabecular, formed of outgrowths of the inner ends of the septa; it is deeply placed in the calicle, the free vertical margins of the primary and secondary septa extending above it for a considerable height.

The single specimen obtained is evidently abnormal in its arrangement in fives. This arrangement is in the specimen perfect; there are exactly forty septa—ten primary and secondary in dimensions, ten tertiary, and twenty quaternary. Count Pourtalès has received from the "Blake" dredgings a specimen with six systems, but which otherwise agrees with the present.[1]

Extreme breadth of the calicle, 24·5 mm. Extreme height, ·11 mm.

Station 50, off Nova Scotia. 1250 fathoms.

*Flabellum conuis*, n. sp. (Pl. VII. figs. 6, 6*a*, 6*b*).

The corallum is light, thin, and fragile, and of a very pale pink colour. It is conical in form, slightly compressed. The wall is covered with an opaque white epitheca to within a short distance from the margin of the calicle. The base is bluntly pointed without trace of adherence. It is marked with wavy transverse accretion ridges and lines. The primary and secondary costæ are slightly elevated broad ridges, broken here and there by the transverse accretion ridges; the primary are more prominent than the secondary. Between the costal ridges the surface of the wall is slightly hollowed out; there are no costæ of lower order. The mouth of the calicle is oval in outline, with a

[1] Pourtalès, Bull. Mus. Comp. Zool., Harvard, No. 9, vol. v. p. 203.

tendency to be polygonal by the formation of angles opposite the primary and secondary costæ. There are six systems of septa and four complete cycles. The primary septa are equal to the secondary, and the septa are quite symmetrical and regular in arrangement; they are not exsert, but the margin of the calicle is slightly dentate. The septa are extremely delicate and thin, and though in their main course perfectly straight are, when carefully examined, seen to be finely wrinkled throughout. All the septa but the quaternaries are complete. The inner borders of the primary and secondary septa are perpendicular, and surround a very deep but narrow, elongate fossa, at the bottom of which is the columella, oval in outline, composed as usual in the genus of twisted outgrowths from the bases of the septa.

This species is well distinguished by its simple conical form, the small extent to which it is compressed, and its extremely fragile structure.

Height of the corallum, 29 mm. Longer diameter of the calicle, 30 mm. Shorter diameter, 25 mm.

Station 218. Lat. 2° 33′ S., long. 144° 4′ E. Off the Admiralty Islands. 1090 fathoms. A single specimen only dredged.

*Flabellum patagonichum*, n. sp. (Pl. XV. figs. 1–7 and 1*a*–7*a*).

The corallum is attached when young, free when adult, conical, somewhat compressed, with smooth surfaces. The lateral borders of the corallum, which are simply rounded, are inclined to one another at an angle of about 75°, and the faces are inclined to one another in their middle lines about 55°. The surface is covered with a light-brown epitheca to very near the margin of the calicle. In all young specimens there is a distinct short pedicle. In some adult specimens this pedicle is still preserved, in others it is obliterated, and the cone ends with straight sides in a simple blunt point. The wall is marked with transverse wavy accretion lines. There are no costæ, but in most of the specimens there occur shallow furrow-like depressions, formed by slight infoldings of the wall along the lines which might be occupied by the primary and secondary costæ.

The outline of the mouth of the calicle is oval, the summits of the short axis are very slightly higher than those of the long axis. The margin of the calicle shows slight denticulations corresponding with the primary, secondary, and tertiary septa. There are six systems and four complete and regular cycles in all the specimens. The septa, which are very thin and straight, are usually slight red coloured, as is also the wall of the corallum where not invested with epitheca. The faces of the septa bear small pointed granules disposed in curved lines upon them. The primary and secondary septa only are complete, and are equal, the quaternary are very slightly prominent from the wall for the whole depth of the calicle. In many specimens the free margins of all the septa are irregularly serrate.

The columella varies much in development. In some specimens it is represented by

four or five stout ragged outgrowths from the bases of the septa only, which do not fuse but leave the interior of the calicle open to the view to its very apex; in others similar but smaller processes are present more abundantly, and join one another to form an elongate mass connecting the bases of the septal margins.

A complete series of young specimens of this coral was obtained. The youngest calicles occur attached to the adults. They are closely similar in form to those of *Flabellum alabastrum* (Pl. VII. fig. 2, *a*, *b*). They are at first oval, in transverse section, with slight indentations opposite the origins of the septa. They have six well-marked, nearly or quite symmetrically disposed primary septa, and six secondary. The primary septa do not reach the centre of the calicle until the wall of the calicle has risen to some little height; the secondary septa are much shorter than the primary, and in one specimen the secondary septa are absent in the pair of chambers at one end of the long axis of the calicle. There is, however, no proof of an original condition with only six septa. As the young calicle rises higher it becomes hexagonal in section, and widens out rapidly. It shows a series of accretion lines, which are sometimes so marked as to give the appearance of a new coral budding out of the interior of an old one. As will be seen from the series figured on Plate XV. the septa appear to develop with great regularity in all the systems equally, and the full number of septa is very early attained.

The coral appears nearly allied to *Flabellum thouarsi* (Milne-Edwards and Haime),[1] which occurs at the Falkland Islands; but in that species there are five systems, whereas none of the largest specimens of *Flabellum patagonichum* show any trace of a fifth system.

Extreme height of the largest specimen, 23 mm. Long diameter of the calicle, 28 mm. Short diameter, 21 mm. Long diameter of the newly-formed young calicle, 2·5 mm. Short diameter, 2 mm.

Station 305, off Penguin Island, Patagonia. 120 fathoms. Numerous living specimens.

*Flabellum apertum*, Moseley (Proc. Roy. Soc., 1826, p. 556). (Pl. VI. fig. 7, *a–c*.)

The corallum is much compressed at the base, where it forms a short pedicle, which is attached in one specimen (that figured in the woodcut) to a minute rolled particle of basalt. Above the pedicle the walls of the corallum curve outwards so as to form a widely-open, almost cup-shaped, calicle. The summits of the calicle at the termination of the long axis are a little lower than those at the termination of the short axis. The wall of the calicle presents twelve prominent costal ridges separated by intervening rounded excavations. The primary ridges are more marked than the secondary, and the lateral costæ slightly more prominent than the others, and continued almost to the apex of the

[1] Milne-Edwards and Haime, Hist. Nat des Corall., t. ii. p. 89.

pedicle. The surface of the wall and costal ridges is smooth, and covered with a glistening epitheca. The margin of the calicle is deeply and irregularly dentate with sharply angular prominences, corresponding to the primary and secondary costæ. The septal arrangement is remarkable for its symmetry and simplicity as occurring in a *Flabellum*. There are four cycles of septa in six systems, and these are present in every

*Flabellum apertum* (Moseley). Natural size.

specimen obtained without any irregularity, the systems being all of the same breadth. The columella is little developed, and composed of scanty outgrowths from the inner ends of the septa. The mean proportion of the axes of the series is about 100 to 137.

Extreme height of the largest specimen, 20 mm. Length of the longer axis of the calicle, 34 mm.; of the shorter axis, 23 mm.

Station 145, off the Prince Edward Islands, South Indian Ocean. 310 fathoms. Six specimens.

Station 3, off Cape St Vincent, Portugal. 900 fathoms. Two specimens, much decomposed.

*Flabellum japonicum*, n. sp. (Pl. VII. fig. 3, 3*a*; Pl. XVI. fig. 12).

The corallum is wedge-shaped, with evenly-curved sides meeting at the gently curved lateral costæ. The lateral costæ make with one another an angle of about 110°, and the inclination of the faces to one another is about 60°. The surface of the wall is covered with an opaque white epitheca all over, except for a narrow zone close to the calicular margin, which is glistening and polished, and was evidently covered by living tissue in the recent state of the coral, which ceased at the line of commencement of the epitheca. Near its upper border for a wide zone the epitheca is often blackened. The faces of the corallum are evenly curved, and the costæ are only just indicated upon them. The lateral costæ are sharp but not prominent, and their edges are slightly sinuous. The corallum terminates in a very short bluntly-pointed pedicle. The mouth of the calicle is oval in outline, the margin being slightly excavated opposite each of the half systems. The summits of the shorter axis are somewhat higher than those of the longer, the upper borders of the faces being gently curved. There are six systems and five cycles of septa; those of the three inferior cycles are incomplete. The septa are of a dull red colour

in the specimens obtained living. The edge of the calicle is notched, the resulting serrations corresponding with the primary, secondary, tertiary, and quaternary septa. The serrations corresponding with the quaternary septa are as high as, or higher than, those of the tertiary septa. The septa are nearly straight, but slightly undulate all over; their surfaces are sparsely covered with minute-pointed granules. The columella is made up of abundant, very stout, and unusually contorted fascicular outgrowths from the septa. The soft tissues of the living animal are of a dark madder colour. There are forty-eight tentacles disposed at the inner margins of the septa at successively greater intervals from the mouth of the animal, as shown in the figure (Pl. XVI. fig. 12). The tentacles are of four sizes corresponding with the septa.

This species appears to come near *Flabellum sinense*, Milne-Edwards and Haime, of which I have seen specimens in the Turin Museum, from Miocene deposits at Turin.

Height of the largest specimen, 35 mm. Longer diameter of the calicle, 50 mm. Shorter diameter, 40 mm.

Station 232, off Enosima, Japan. 345 fathoms. About eight specimens.

*Flabellum alabastrum*, Moseley (Proc. Roy. Soc., 1876, p. 555). (Pl. VII. figs. 1, 1*a*, 1*b*, 2, 2*a*, 2*b*; Pl. XVI. fig. 11.)

*Flabellum alabastrum* (Moseley). Slightly enlarged.

The corallum is of a beautiful light-pink colour, and is very thin and fragile. It is wedge-shaped, the calicle arising from an attenuated pedicle. The lateral costæ make an angle with one another of from 120° to 140°, and are sharp and moderately prominent, with an irregular edge. The external surface of the calicle is covered with a glistening epitheca, which is whitish in colour towards the pedicle. The primary and secondary costæ on the faces are almost as well marked as the

lateral costæ, and appear as irregularly dentate ridges separated by slight depressions. The calicle is compressed from side to side in the centre, so as to be narrowest there. Its upper margin is curved, describing about one-third of a circle. There are six systems of septa disposed in five cycles. The septa, which are extremely thin and fragile and covered with rounded granules, are disposed in rows. The primary septa approximately equal to the secondary, giving somewhat the appearance of twelve systems. These septa are broad and prominent, with a rounded superior margin, and show curved lines of growth very distinctly. The septa of the third, fourth, and fifth cycles successively diminish in breadth, and are thus very markedly distinguished from one another and from the primary and secondary septa. The quaternary septa join the tertiary a short distance before reaching the columella. The septa of the fifth cycle are incomplete. The margin of the calicle is very deeply indented, the costæ corresponding to the primary and secondary septa being prolonged in conjunction with the outer margins of those septa into prominent pointed processes. Similar but shorter costal prolongations accompany the tertiary septa and some of the quaternary. Between each of the sharp projections thus formed the edge of the wall of the calicle presents a curved indentation. The fossa of the calicle is extremely deep and capacious. The columella is elongate, with a nearly smooth surface formed of processes from the bases of the septa. All three perfect specimens obtained were of nearly the same size, and of closely similar form, being all pinched together towards the centre and showing no tendency to broaden out there, nor to become irregular or to split up into fragments. The two broken specimens are in form, as far as they go, precisely similar to the perfect ones.

Judging apparently only from the woodcut given in Nature,[1] and without having referred to my paper in the Proceedings of the Royal Society, Professor Lindström has placed this species with *Flabellum laciniatum*. He describes specimens dredged off the Azores in from 200 to 300 fathoms as agreeing with certain descriptions and figures given by Professor Martin Duncan and myself.[2] I can see no resemblance between Professor Duncan's figures cited by him and my own; nor can I think, after examining specimens of *Flabellum laciniatum* lent to me by Professor Duncan, that the two corals can be identical. I cannot, however, tell what amount of variation a long series of specimens might show. The large size, extreme lightness and fragility, and the peculiarly curved contours of the deep-sea form seem to be sufficient to separate it specifically. The Challenger specimens were obtained off the Azores also, but from a depth of 1000 fathoms.

With the adult corals were obtained two very small specimens, which seem almost certainly to be the young of the present species. They are in the form of small hexagonal columns slightly expanded above, and showing on each of the six faces a

[1] Nature, vol. viii. p. 400. [2] G. Lindström, Actinology of the Atlantic Ocean, p. 12.

series of transverse curved accretion striæ. The six angles are the primary costæ, the secondary costæ are just marked as faint narrow ridges between them. The young corals are perfectly symmetrical, the hexagonal mouth of the calicle is slightly elongate, the two lateral of the six sides being slightly broader than the four end ones. There are twelve septa. The six primary meet the small oval columella at the base of the fossa and calicle with their inner margins; the six secondary are incomplete and are not continued quite down to the bottom of the calicle. The base of the calicle is attached by a smooth, glistening, terminal surface of coral matter, the under surface of a thin, horizontal lamina which forms the bottom of the calicle. In this lamina can be plainly seen embedded the bottoms of the six primary septa symmetrically arranged, and without any secondaries, showing that six septa symmetrically disposed were originally developed first in the young corallum. The outline of the bottom of the calicle is not hexagonal, but bounded by four nearly equal curves, one at each end and two lateral. The hexagonal form is gradually assumed higher up. The margin of the calicle is already dentate in the young coral, larger dentations corresponding with the primary septa and minute ones between them answering to the secondaries being present.

Two of the adult specimens obtained were alive, and expanded themselves when placed in sea-water, notwithstanding the depth from which they came. The inner margin of the disk around the elongate mouth presents a regular series of dentations corresponding with the septa, and is of a dark madder colour; the remainder of the disk is of a pale pink. The tentacles take origin directly from the septa; they are of an elongate conical form; those of the primary and secondary septa are equal in size, and placed nearest the mouth, and at equal distances from it, together with the tertiary tentacles, which are somewhat shorter, but are placed in the same row with them. The tentacles of the fourth and fifth cycles are successively smaller, and placed at successively longer distances from the mouth. Placed on either side of each tentacle of the fifth cycle, and again somewhat nearer to the margin of the calicle, are a pair of very small tentacles which have no septa developed in correspondence with them. The number of tentacles is thus ninety-six. The tentacles are light red in colour. Between their bases are stripes of yellowish-red and pale-greyish. For some account of the anatomy of this species, see the Introduction, p. 130, and also pp. 163, 164 of the present memoir.

Measurements of an adult specimen: extreme height of the calicle, 50 mm.; longer diameter of the calicle, 65 mm.; shorter diameter, 30 mm.

Young specimens: height of the calicle, 5 mm.; longer diameter of the calicle, 4 mm.

Stations 73 and 78, off the Azores, from 1000 fathoms. Five adult specimens, three living and two dead and fragmentary, and two very young specimens.

*Flabellum patens*, n. sp. (Pl. VI. figs. 4, *a*, 5, *a*).

The adult corallum is wedge-shaped, with smooth sides. The form varies very much; the lateral costæ, which are sharp and more or less indented, varying in the angle which they make with one another between 100° and 160°. The inclinations of the lateral faces to one another vary from 30° to 50°. The surface of the corallum is smooth in very young specimens, polished, and of a red-brown colour; the principal costæ are only just visible. There are distinct curved accretion lines in all the specimens, and in some deep transverse plications indicating a tendency to fission as in *Flabellum stokesi*, but this does not occur. There is a distinct short cylindrical pedicle. The summits of the short axis of the calicle are much higher than those of the long axis, and the lateral margins of the calicle describe even curves of nearly half a circle. The septa are very numerous, being doubtless added to in growth at the ends of the long diameter of the calicle, as in *Flabellum irregulare*, Semper.[1] In one perfect specimen there are 192 septa of three sizes, twenty-four being complete, and, in appearance, equal and primary. In another more adult specimen there are 268 septa of four different dimensions, but the septa are a little irregular, and, at one end, the corallum has evidently had a considerable piece broken away, and this has been restored with a remarkable maintenance of symmetry in the form of the corallum and septal arrangement. In another specimen there are 248 septa. The faces of the septa are covered with fine pointed granules. There is a deep elongate but narrow fossa well filled up at its bottom by columellar outgrowths. This coral is closely allied both to *Flabellum stokesi* and *Flabellum pavoninum*. It differs from *Flabellum stokesi* in not breaking away from the stock as growth proceeds, and multiplying by fission, and also in its more widely open form. In the young condition it is often very like *Flabellum stokesi*, indeed hardly distinguishable, but this fact is merely in accordance with the usual law of the likeness of the young of allied animals. From *Flabellum pavoninum*, *Flabellum patens* differs in having its faces less smooth than the former, and in having more septa.

Extreme height of the calicle of a large specimen, 43 mm. Extreme breadth of the calicle, 55 mm. Shorter diameter of the calicle, 28 mm.

Station 192, off the Ki Islands. 129 fathoms. Six specimens.

*Flabellum stokesi*, Milne-Edwards and Haime (Hist. Nat. des Cor., vol. ii. p. 96).

*Flabellum variabile*, Semper, Z. f. Wiss. Zool., 1872, p. 245, = *Flabellum oweni*, *Flabellum aculeatum*, and *Flabellum spinosum*, all of Milne-Edwards and Haime, *l.c.*

Professor Semper, in his memoir entitled Ueber Generationswechsel bei Steinkorallen, shows the identity of the three above-cited species of MM. Milne-Edwards and Haime, and their relations to one another in development. One of the original names

[1] Semper, Generationswechsel bei Steinkorallen, Z. f. Wiss. Zool., 1872, p. 242.

of the species must necessarily be retained instead of Semper's new name, and as they are of the same age I retain the term *stokesi* as least likely to lead to error.

We dredged abundant specimens of this coral in the Arafura Sea, very variable in form, and bearing out Professor Semper's conclusions in every way.

Station 188. Arafura Sea. 28 fathoms.

Station 190. Arafura Sea. 49 fathoms.

*Flabellum australe*, n. sp. (Pl. VII. figs. 4, *a*, 5, *a*, *b*).

The adult corallum is very large, dense, and heavy. It is in the form of a compressed wedge, triangular in outline. The lateral costæ make with one another an angle of from 70° to 90°. The surfaces of the faces are smooth and glistening, of a brownish colour, marked with evenly curved transverse accretion lines, sometimes with numerous very fine costal markings all over, sometimes with only a few obscure primary and secondary ridges near the base. There is a distinct short cylindrical pedicle. The lateral costæ are sharp and rough-edged, somewhat jagged. They usually cease towards the margin of the calicle where the angles of the corallum are evenly rounded off. The form of the mouth of the calicle is extremely elongate and narrow, the ratio of the two axes being about as 100 to 40. The summits of the shorter axis of the calicle are somewhat higher than those of the longer axis, and the upper borders of the faces are evenly curved, with smooth edges. The septa are white, contrasting in colour with the brown wall of the calicle. They are stout, and straight, and covered with fine pointed granules on their faces. All the septa are very low near the margin of the calicle, to which they do not quite extend, a narrow zone of bare calicular margin being present all round the mouth of the calicle. It appears as if their free borders were so to speak cut away close to the calicular margin. The curved free edges of the principal septa bend over and descend nearly vertically to bound the fossa, which is extremely narrow, deep, and long. There are in one adult specimen, that figured, 48 complete septa sensibly equal to one another, and 144 incomplete septa of two different sizes—192 in all. In one specimen, there are 96 septa on one side, and 92 on the other. In another, 80 on one side, and 85 on the other. Another, 92 on one side, 94 on the other, and 28 of these complete on each side. A young one has 17 complete on each side, and 82 on each side in all. In all the specimens the septa are of three dimensions. The columella lies so deep in the fossa as to be almost invisible.

This species is well distinguished by its large size, its shape, and the peculiar cutting away, as it were, of the septal borders close to the margin of the calicle. The very young specimens are closely like those of *Flabellum patens* and *Flabellum stokesi*, though the adults are extremely different. *Flabellum distinctum*, Milne-Edwards and Haime, is also in its young stages very like the present species, but differs in having a wider mouth to its calicle. In *Flabellum australe* this is characteristically narrow.

Extreme height of the largest specimen, 57 mm. Extreme breadth, 65 mm. Shorter diameter of the calicle, 28 mm.

Eleven specimens. Station 163. Off Twofold Bay, New South Wales. 120 fathoms.

*Flabellum transversale*, n. sp. (Pl. VI. figs. 6, *a*).

The corallum is dense and heavy; it is elongate compressed conical in form, with rounded surfaces and without lateral ridges. The lateral borders make with one another an angle of about 30°. There is a short pedicle, with a small scar of attachment twisted to one side. The entire wall of the corallum is marked by deep curved transverse sulci and rounded ridges formed by successive intervals in growth. These are hardly sufficiently marked in the figure. Very numerous fine costal striæ extend over the whole surface. The calicle is oval in form, the edge of its margin is a little irregular, but not toothed by the septa, the summits of the two axes are nearly on the same level. There are in the single specimen, eighteen complete septa and eighty-eight septa in all, which are of three well-marked different sizes, with a few of a fourth size which apparently were about to have become complete had growth proceeded. The septa are continued to the margin of the calicle. They are stout and straight, with abundant fine pointed granules on their surfaces. The fossa is moderately wide, and extends down for about one-third the depth of the calicle, where it is bounded by the usual columella. The lower part of the free margins of the septa are finely serrate.

This coral seems nearly allied to Professor Semper's *Flabellum irregulare*,[1] but differs from it in its greater irregularity of shape, its bent pedicle, and more widely open fossa.

Height of the single specimen, 35 mm. Long diameter of the mouth of the calicle, 23 mm. Short diameter, 14 mm.

Station 162. Bass Straits, Australia. 38 fathoms. A single specimen only.

*Flabellum curvatum*, n. sp. (Pl. VI. figs. 3, *a–d*).

The corallum is white, and is trumpet-shaped, bent and twisted, and compressed. It is attenuate below, being drawn out gradually into a pedicle, which is usually bent sharply to one side, and in one specimen (that figured), has a small fragment of stone attached to it. Besides the bend in the pedicle, the corallum is also always much curved in the plane of compression. The lateral regions of the wall are evenly rounded, and the lateral surfaces are inclined to one another at an angle of about 50°. The entire surface is covered with an opaque white epitheca, due to decomposition of the exposed dead outer surface. It shows transverse accretion folds, and is marked all over by

[1] Semper, *l.c.*, Z. f. Wiss. Zool., 1872, p. 242.

closely-set very fine grooves, which correspond to the septa in position, and appear like fine longitudinal striæ. At the margin of the calicle is an extremely narrow zone of glistening white coral substance marking the limit reached by the soft tissues in the living coral. The mouth of the calicle is oval in outline, and the summits of the two axes are sometimes on the same level, sometimes those of the shorter axis are very slightly higher than those of the longer. The axes have to one another a ratio of about 100 to 150. The margin of the calicle is even, and the septa are not at all exsert. The septa are tolerably stout, with their faces covered with pointed granules; they are in places bent to accommodate themselves to the curves of the corallum. The full number of septa seems to be ninety-six, twenty-four of which are complete; the septa are in the best grown specimens of three different sizes only, but in others four different orders in size are distinguishable. There is a tendency to the development of more septa, and to the completion of more amongst these, on the side of the calicle opposite to the face towards which the corallum is curved. In two smaller specimens, ninety-two and eighty-one septa were counted, with twelve septa complete in one, and thirteen in the other. The septa sometimes do not quite reach to the margin of the calicle, which has its border sometimes very slightly incurved. The fossa is widely open with sloping sides, and extends down for nearly half the depth of the calicle. The columella is made up of very large tortuous processes not very closely intertwined.

Extreme height of the largest specimen, 48 mm. Long diameter of the calicle, 40 mm. Short diameter, 25 mm.

Station 320, off the mouth of the Rio de la Plata. 600 fathoms. Eight specimens.

### *Rhizotrochus*, Milne-Edwards and Haime.

*Rhizotrochus fragilis*, Pourt.

*Rhizotrochus fragilis*, Pourtalès, Bull. Mus. Comp. Zool., Harvard, No. 7; Deep-Sea Corals, p. 17., pl. iv. figs. 1–4.

Station 142, off the Cape of Good Hope. 150 fathoms. One specimen.

A very broken fragment of the same species (?). Off Api Island, New Hebrides. 50 to 125 fathoms.

### Family Oculinidæ, Verrill.

### *Cyathohelia.*

*Cyathohelia axillaris*, Milne-Edwards and Haime (Hist. Nat. des Cor., vol. ii. p. 110).

A single specimen, broken, but with many of the calicles fresh looking, as if the coral had recently been living, was dredged.

Station 196. Off the Moluccas. Lat. 0° 48′ S., long. 126° 58′ E. 825 fathoms.

### *Neohelia*, n. gen.

Corallum, with a very abundant and diffuse cœnenchym encrusting the stems of Gorgonoids, with very short branches only. Calicles with the septa arranged in five systems, which are often fused together by the cœnenchym; gemmation irregularly dichotomous.

Five systems and four cycles of septa; a deep fossa; no columella.

*Neohelia porcellana*, n. sp. (Pl. X. figs. 7, 7*a*).

The corallum rises from a broad base in a thick irregular column, encrusting dead Gorgonoid stems, and the stones to which these are attached. There is an abundant diffuse, bluish-white, semitransparent cœnenchym which solders together the branches, and covers the invested objects so as completely to hide them. The central column is composed partly of fused branchlets of the coral itself, partly of invested gorgonoid structures. Many of the branchlets of the coral, which appear, as if entirely composed of its own structure, are found when broken, to be traversed internally by a flexible Gorgonoid branch almost as large in diameter as themselves, as seen in a broken branch in the specimen represented in figure 7, on the right hand side in the sketch. Besides these encrusting branchlets, the corallum bears also all over some very short branches, which are solid and composed of its own structures entirely. The surface of the cœnenchym is marked all over by very slightly elevated rounded ridges which traverse it irregularly, but with a general longitudinal direction, and are continuous at the margins of the calicles with the costæ. The gemmation is irregularly dichotomous. The calicles are small, and circular in outline. There are uniformly in all the calicles five systems of septa, and three cycles—twenty septa in all. The septa of the three cycles are distinctly unequal. The septa are very slightly exsert, and are continued just over the margin of the calicle as very short costæ; they are straight, smooth, and thin-edged, near the mouth of the calicle; but deep down, within the fossa, their fine margins become thickened and sinuous, and covered with granules, and the primaries and secondaries meet one another, but without the formation of a columella. On the young branches the calicles are short and cylindrical; on the main stem they become buried up to their margins, or obliterated by the cœnenchyma.

All the three specimens obtained encrust Gorgonoid stems in a closely-similar manner; two of them encrust also stones to which the Gorgonoid stem is attached. I have counted the septa in a very large number of calicles, but have found them alike in all, namely, twenty, so that in this matter the coral resembles certain species of

*Madracis*. Many of the branchlets in the specimens are broken but, being traversed by flexible supports, remain *in situ*. In one specimen there are several instances in which a young calicle has been budded directly out of the mouth of an old one in the same direction.

Extreme height of the largest specimen, which however is much reduced by breakage, 50 mm. Average breadth of the mouths of the calicles, 1·5 mm. Average height of the young calicles, 2 mm.

Station 177. Off Api Island, New Hebrides. 63 fathoms. Three specimens.

### *Bathelia*, n. gen.

Corallum arborescent, massive; calicles disposed alternately in nearly straight rows on either sides of the several branches, with very prominent margins. Cœnenchym white, compact, and dense, with its surface covered entirely by curved striæ continuous with the costæ. Calicles deep and widely open, with four cycles of septa, and a single crown of pali. Columella large, composed of numerous trabeculæ.

The genus is distinguished from *Oculina* by its single crown of pali, and the distichous arrangement of the calicles; from *Sclerohelia* (Milne-Edwards and Haime[1]), it is distinguished by the costal striations, depth, and prominence of the calicles, and number of septa.

*Bathelia candida*, n. sp. (Pl. VIII. figs. 1–6).

The corallum is of a pure white; it is arborescent, with a tendency to assume an espalier form. The branches are rounded, and decrease very gradually in size towards the summits. The cœnenchym is hard and dense, its surface is marked all over by curved longitudinal striæ continued from the costæ at the margin of each calicle. Calicles oval in outline, being slightly compressed in a plane at right angles to the length of the branches, with very prominent margins disposed alternately and distichously on the several branches as the result of alternate gemmation. Costæ not very prominent, and present only at the very borders of the calicles. Septa slightly exsert, very little prominent from the wall of the calicle interiorly, so that the fossa is deep and widely open. Forty-eight septa present, that is to say, six systems and four complete cycles, but the primary, secondary, and tertiary septa are nearly equal. Twelve well-marked pali opposite the tertiaries. The fossæ of the calicles are somewhat curved downwards towards the bases of the branches, and the septa are slightly curved in correspondence. The septa are thin, and covered on their faces with small pointed granules. Some of the pali are sometimes wanting, and appear sometimes to become lost amongst the trabeculæ of the columella. The columella is large, composed of numerous vertical branched trabeculæ.

[1] MM. Milne-Edwards and Haime, Hist. Nat. des Cor., vol. ii. p. 112.

The two calicles figured in the plate are, unfortunately, very badly drawn and obscure, and do not show the pali and columella at all distinctly.

Extreme height of the largest specimen, 130 mm. Average breadth of the calicles, 10 mm. Diameter of the stem at the base of the stoutest specimen, 12 mm.

Station 320. Off the mouth of the Rio de la Plata. 600 fathoms.

### *Lophohelia.*

*Lophohelia prolifera*, Milne-Edwards and Haime (Hist. Nat. des Cor., vol. ii. p. 117). (Pl. VIII. figs. 7, 8.)

This coral, so abundantly dredged by the "Porcupine" Expedition, and obtained also in deep water by the American expeditions, was dredged only four times by the

*Lophohelia prolifera* (M.-Edw. and H.). Three-fourths the natural size.

Challenger, but once in very great abundance. The specimens then obtained showed great varieties in their form, and, amongst others, examples of Professor Martin Duncan's variety *gracilis*.[1] Professor Duncan has dwelt at length on the structure, affinities, and varieties of this species in his memoir on the Madreporaria of the Deep Sea.[2]

[1] Madreporaria of the Deep Sea, part i. p. 332, pl. xiii. figs. 1, 2.

[2] *Ibid.*, part i. p. 328, *et seq.*

I give here a woodcut of a specimen dredged by the "Porcupine" Expedition, taken from Sir C. Wyville Thomson's Depths of the Sea.

A large number of the specimens dredged off Nightingale Island were living. The animal was of a uniform dead-white colour, without any pinkish tinge. The mouth is circular, with twelve small plaits at its margin. There are twenty-four tentacles arising from the inner margins of the primary, secondary, and tertiary septa. The tentacles borne by the primary and secondary septa are carried erect whilst the animal is at rest in the expanded condition, whilst those of the tertiary are held more horizontally or are recurved. The tentacles are long and attenuated, terminating in a very slight knob. An elevation or ridge formed by the soft parts leads from the base of each of the primary and secondary tentacles to the margin of the mouth.

Two small fragments of this coral were obtained in two dredgings off the Virgin Islands. One of these is figured on Plate VIII. figs. 7, 8. They agree in having the calicles very short, and at first I thought of referring them to a variety under the term *brachycephala*, but I find closely similar bits amongst the branches of some of the large specimens obtained off the Tristan da Cunha group. Another similar dead fragment was obtained off St Paul's Rocks.

Station 23, off Sombrero Island, Danish West Indies. 450 fathoms. A small fragment.

Station 24, off Culebra Island, Danish West Indies. 390 fathoms. A similar fragment.

Station 109, off St Paul's Rocks, Equatorial Atlantic Ocean. 100 fathoms. A dead fragment.

Station 135, off the Tristan da Cunha group. Off Inaccessible Island. 90 fathoms. Off Nightingale Island. 100 to 150 fathoms. Very large quantities of fine specimens.

*Lophohelia candida*, n. sp. (Pl. IX. figs. 6–13).

The corallum is of a pure white. It branches irregularly, the branches being often curved. It encrusts various objects with its base. The surfaces of the branches are smooth, but marked by very faint, broad, longitudinal tracts. The gemmation is regular and distichous. The mouths of the calicles are small, with a slight border of costæ round their margin in young specimens. There are six systems and three complete cycles. The secondary septa are markedly smaller than the primary. The septa are never exsert. As growth proceeds an abundant cœnenchym is developed which buries the originally long and slender calicles, and forms thick stems (fig. 12) somewhat compressed in shape, on the sides of which the small mouths of the calicles are seen in rows barely prominent beyond the surfaces of the cœnenchym. There is no columella. This species is closely allied to *Lophohelia ramea* and *Lophohelia* (= *Amphihelia*) *oculata*, as described by Professor Duncan. After comparing my specimens with his, I think it

better to separate the present form. It differs from both species in the length of its calicles in the young condition, and in its very regular distichous gemmation, also in the absence of a columella, and in the nature of the striation of the surface. I follow Professor Duncan in placing together the genera *Amphihelia* and *Diplohelia*, but include both under *Lophohelia*. Professor Duncan combines *Amphihelia* and *Diplohelia*, and places *Lophohelia* far away because of its dissepiments. Count Pourtalès combines *Lophohelia* and *Amphihelia*, and separates with some doubt *Diplohelia*. Two of the specimens are attached to bundles of Hyalonema spicules, which they spread over with their bases and cement together.

Height of the largest branching specimen, 75 mm. Diameter of the mouths of the calicles, 2 to 2·5 mm.

Station 23, off Sombrero Island, Danish West Indies. 450 fathoms.

*Lophohelia arbuscula*, n. sp. (Pl. VIII. figs. 9, 10).

The corallum is small, arborescent in form, formed by alternate gemmation. The surface of the cœnenchym is perfectly smooth, polished, and glistening. There are no costæ. The septa are very slightly exsert. There are six systems and three cycles, the primary and secondary septa being complete. In some calicles there is a columella.

The single fragment only which is figured was obtained. The coral is closely like some small specimens of *Lophohelia ramea* in Professor Duncan's collection, but differs in the complete smoothness and polish of the cœnenchym. The specimen is dead and somewhat altered by decomposition; but, after examining it with the microscope, I do not think that the polish of the cœnenchym has a *post-mortem* appearance, or that the surface has altered its texture.

Extreme height of the specimen, 50 mm. Average breadth of the calicles, 2·5 mm.

Station 194, off Banda Island, East Indies. 200 or 360 fathoms.

*Lophohelia tenuis*, n. sp. (Pl. VIII. figs. 11–14).

The corallum is small and delicate, formed by distichous marginal gemmation. There is little or no cœnenchym, the calicles being clearly differentiated, elongate, and attenuated at their bases. The surfaces of the calicles are marked with longitudinal very fine ridges composed of rows of distinct rounded granules (very badly shown in the figure), with which in places the general surface is also covered. The costæ are very slightly exsert. There are six systems and three cycles; the free margins of the septa are finely serrate.

Only a fragment of this coral was obtained. It seems to be well distinguished by its extremely small size and the peculiar rows of granules upon its surface. It is most unfortunate that the figure I have to offer of them is so imperfect.

Length of each calicle, 4 mm. Diameter of the mouths of the calicles, $2\frac{1}{2}$ mm.
Station 210, between Panglao and Siquijor Islands, Philippine Islands. 375 fathoms.

### *Solenosmilia.*

*Solenosmilia variabilis*, Duncan, Madreporaria of the Deep Sea, part i. p. 328, pl. xiii. figs. 11–18. (Pl. IX. figs. 1–5).

*Lophohelia tubulosa*, Studer, Monatsbt. der K. P. Akad. der Wiss., 1878, s. 631, taf. i. fig. 8, *a–e*.

I give a series of figures of this species because it is a very widely-spread and characteristic deep-sea form, and varies exceedingly. Many specimens dredged by us were dead, old, and much broken, but always recognisable by the peculiar mode of branching and the texture of the cœnenchym. The peculiar mode in which the young terminal calicles communicate with one another whilst fission is proceeding, as described by Professor Duncan, is shown in figure 3. Since the plate was prepared Pourtalès has published very good drawings of the same subject.[1] Professor Studer has shown that a somewhat similar condition exists in *Lophohelia*.[2]

In some of his specimens Professor Duncan observed the presence of a peculiar dark green pigment. It would be of great interest to submit this colouring matter to spectroscopic examination. In none of the Challenger specimens was this coloration observed, but this may be due to the fact that they were placed at once either in strong alkaline solutions or in spirit. Nearly all of them have a peculiar light brown colour; and some were entirely coated with a thin layer of the peroxide of manganese so abundant in the deep sea, just as was the dead Corallium obtained by us in very large quantities off the Canary Islands.[3] In the Natural History Museum at the Jardin des Plantes is a similar specimen of *Corallium rubrum*, coated with a black substance, evidently manganese. It is from the Mediterranean, and labelled "Corail norici dans la vase," "Corail mort des pecheurs."

Studer's *Lophohelia tubulosa* is evidently not distinct from the present species.

Station 135, off Tristan da Cunha. 1000 fathoms.

Station 145, off the Prince Edward Islands, South Indian Ocean. 310 fathoms.

Station 344, off Ascension Island. 420 fathoms.

Abundance of the coral was obtained at all the above localities.

[1] Pourtalès, Bull. Mus. Comp. Zool., Harvard, vol. v. No. 9, Corals, pl. i. figs. 1–3.
[2] Monatsbericht der K. Preuss. Akad. der Wiss., Nov. 1877, s. 632.
[3] Sir C. Wyville Thomson, The Atlantic, London, 1877, vol. i. p. 173.

Family Stylophoridæ, Pourtalès.

*Madracis.*

*Madracis asperula*, Milne-Edwards and Haime (Hist. Nat. des Coraïls, t. ii. p. 139).

Very large quantities of this coral were brought up by the swabs from 30 fathoms, off Bermuda. The bottom was evidently covered thickly with the coral.

On the South-west Bank, Bermuda. 30 fathoms.

Off the shore of Fernando de Noronha, in shallow water.

At St Vincent, Cape Verde Islands. Shallow water.

*Axohelia.*

*Axohelia dumetosa*, Duch.

One specimen obtained is identical with one named by Count Pourtalès, and agrees also with his descriptions and figures. He retains the genus *Axohelia* apart from *Madracis* for the species with compact cœnenchyma.[1]

Station 33, off Bermuda. 435 fathoms.

Family Astræidæ, Dana.

*Sphenophyllia*, n. gen.

Corallum solitary, free, pedicellate, compressed, with septa finely denticulate at the summits, and numerous sharp-edged costæ which are denticulate, rendering the corallum exceedingly rough. A scanty epitheca at the base; no endotheca or exotheca; a well-developed lamellar columella.

The genus is allied to *Antillia* (Duncan),[2] but differs in having no endotheca or exotheca, and differs from *Trachyphyllia*, to which it has also affinities, in being solitary.

*Sphenophyllia flabellum*, n. sp. (Pl. X. figs. 1, 1*a*, 1*b*).

The corallum is white, extremely compressed, conical and deltoid in form. The summits of the short axis are higher than those of the long axis; and the lateral margins of the calicle are evenly curved, sometimes a little undulating. There is a distinct pedicle, with trace of attachment. Around the pedicle, and for a short distance above it, there is a scanty opaque epitheca. The surface is roughened all over by sharp-edged costal ridges, which converge from the calicular margin towards the pedicle all round. These costæ correspond to the major septa; they are sharp-edged and finely dentate throughout their extent, so that the outer surface of the coral is extremely rough.

[1] Pourtalès, "Hassler" Expedition, p. 40.

[2] West Indian Corals, Proc. Geol. Soc., Nov. 1863, p. 28.

Between these costæ near the margin of the calicle are others, short and rudimentary, corresponding to the septa of inferior order. The calicle is elongate-oval in form, with a more or less sinuous margin caused by twisting or irregular indentation of the calicular wall.

The septa are very numerous, and of three sizes; there are in two specimens from twenty-four to twenty-six complete septa on each side. Between each pair of these major septa are three septa of inferior order which are incomplete. The major septa are slightly exsert. All the septa are finely denticulate on their free margins, and many of them show also dentation on their free margins at some depth in the calicle. The columella is lamellar in form, partly spongy in structure, and beset with fine pointed granules; it leads in a direct line between the median major septum at either end of the calicle. The fossa is widely open in the upper part of the calicle, but contracts and becomes narrow and vertical before the columella is reached.

This species seems closely allied to Professor Martin Duncan's *Placotrochus costatus*;[1] but from the general appearance of the coral, its roughness, the dentation of its costæ, and denticulation of the septa, there can be little doubt that it is allied to *Antillia* and the Astræidæ. At all events it appears to have no affinities with *Placotrochus lævis*, the type of MM. Milne-Edwards and Haimes' genus, which is hardly separable from *Flabellum*.

Extreme height of the largest specimen, 25 mm. Extreme length of the calicle, 44 mm. Length of short axis of the calicle, 17 mm.

Locality unknown, the label having been unfortunately mislaid.

### *Tridacophyllia*, Blainville.

*Tridacophyllia cervicornis*, n. sp. (Pl. X. figs. 2, 2*a*, 2*b*, 2*c*, B*a*).

This coral resembles *Tridacophyllia alcicornis* of Mr W. S. Kent,[2] but differs in the form of the branches and mode of branching. The corallum is of a yellowish colour. It is cyathiform below and attached by a stout cylindrical pedicle, but above the margin of the cup grows out into a number of irregularly ramifying branches. These branches, which are narrow, flattened laminæ, are often recurved at their edges; on their inner faces prolongations of the septa are continued to their very tips; their outer faces are smooth and directly continuous with the outer surface of the pedicle and cup, and like it devoid of costæ and covered with fine granules disposed in obscure more or less longitudinal lines. The calicle has a deep fossa, wide above, but narrow and elongate below. No columella is visible in its depth, but the principal septa appear to meet one another at its bottom. The septa are numerous, closely set, and of three or four orders; they are

[1] Duncan and Wall, Geology of Jamaica, Proc. Geol. Soc., Nov. 1864, p. 9, pl. fig. 4, *a*, *b*.

[2] Proc. Zool. Soc., 1871, p. 283.

sinuous in their course in the upper part of the calicle. Their edges are very finely denticulate, some of them are very thick; they are prolonged to the very tips of the branching processes, where they have short septa of inferior order intercalated between them (fig. 2*b*); they lap round over the margins of the processes a short distance so as to notch them (fig. 2*c*). There is no trace in either of the two specimens obtained of any development of additional individuals, and of a compound corallum.

Extreme height of two specimens, 25 mm. and 22 mm. respectively. Extreme breadths, 25 mm. and 20 mm.

Locality unknown. The specimens were received from Captain J. F. L. P. Macleat, R.N., Commander of the Challenger.

*Astræa*, Milne-Edwards and Haime.

*Astræa abyssorum*, n. sp. (Pl. X. figs. 4, 4*a*).

The corallum is white, and forms small elevated masses composed of from about fifteen to twenty-five calicles. The budding takes place at the point of union of several calicles. The calicles are subpolygonal, with irregularly prominent margins, the surface of the corallum being thus very uneven. The fossæ are deep, widely open, and conical. The septa are deeply dentate near the columella, and become gradually less so towards the margins of the calicles. The quaternary septa are fused to the tertiaries at a short distance above the columella. The septa are stout, and thickly beset with granules. The columella is composed of numerous papillæ which occupy a wide area.

Height of the largest specimen, 24 mm. Average diameter of the calicles, 6 mm. Diameter of the largest calicle, 9 mm.

Station 190, Arafura Sea. 49 fathoms.

Station 192, off the Ki Islands. 129 fathoms.

*Cladocora*, Milne-Edwards and Haime.

*Cladocora arbuscula*, Milne-Edwards and Haime.

Simon's Bay, Cape of Good Hope. 10 to 20 fathoms. A single specimen.

Station 33, off Bermuda. 435 fathoms. A dead fragment of the same, possibly not living at that depth.

*Cladocora debilis*, Milne-Edwards and Haime.

A single specimen, fresh, and evidently recently living, is included amongst the products of a dredging off the mouth of the Rio de la Plata in 600 fathoms. The specimen has abundance of a corallinaceous sea-weed attached to it, and I feel uncertain

whether it may not have been actually derived from some other dredging, and have lain for some time entangled in the swabs.

Station 320, off the mouth of the Rio de la Plata. 600 fathoms?

*Cladocora conferta*, n. sp. (Pl. X. fig. 5, 5*a*).

The corallum forms small irregular masses, in which the individuals are closely packed together. In the specimens obtained the interstices in the masses are filled in with extraneous growths of all kinds and particles derived from the sea bottom, which are firmly cemented together. There are six systems and four cycles, three of which are complete, the septa of the fourth cycle being small and rudimentary. There is a well-marked but rather shallow fossa. The pali are irregularly developed, but paliform lobes are usually present on all the septa except those of the fourth cycle; those of the tertiary septa are most prominent, and sometimes form a well-marked and complete crown. The columella is large, and composed of abundant papillæ. The whole of the surface of the corallum and septa is roughened by abundant fine-pointed granules.

Height of the largest specimen, 3 mm. Average breadth of the calicles, 4 mm. to 5 mm.

Off Samboangan, Mindanao Island, Philippine Islands. 30 fathoms and 10 fathoms.

## Family Fungidæ.

### Sub-family Lophoserinæ, Milne-Edwards and Haime.

### *Bathyactis*, n. gen.

Corallum free, discoid, not attached or cup-shaped in the young condition, thin and fragile; primary septa free, the others united so as to form six deltoid combinations; upper margins of the septa usually coalescent over the apices of the deltas. Septa deeply toothed; synapticulæ sometimes abundant, sometimes few, arranged in a series of concentric circles. Columella well developed.

The very widely-distributed coral named by Count Pourtalès *Fungia symmetrica* can scarcely be considered to fall naturally into the genus *Fungia*, especially now that its larger varieties are known. It is obviously, from its general appearance, nearly related to *Lophoseris*. It differs from *Fungia* in having its primary septa free, and in having a well-developed columella. Its extreme lightness and fragility and the regular deltoid arrangement of its septa in combination with the presence of synapticulæ, are characteristic of it.

I am not sure whether *Fungiacyathus fragilis* of Professor M. Sars[1] will not prove

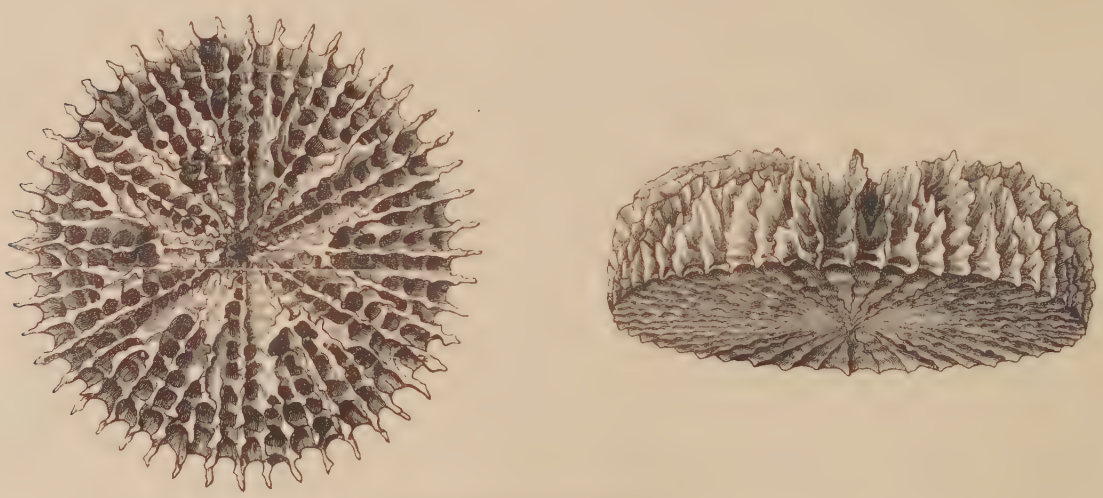
[1] Professor M. Sars, On Some Remarkable Forms of Animal Life from the Great Depths off the Norwegian Coast, p. 58, pl. v. figs. 24–32. Christiania, 1872.

identical with *Bathyactis symmetrica*. If so, the name *Fungiacyathus* will take priority. *Fungiacyathus fragilis* agrees with *Bathyactis symmetrica* in all respects excepting that it has no synapticulæ. In some of the Challenger specimens there are very few synapticulæ indeed, but in none are these structures entirely absent. I therefore hesitate to place the two forms together at present. There can be little doubt that they are closely allied, and what little I have seen of the soft parts of *Bathyactis symmetrica* goes to confirm such an opinion.

*Bathyactis symmetrica*, Moseley (Pl. X. figs. 1–13; 1*a*–13*a*).

*Fungia symmetrica*, Pourt., Deep-Sea Corals, p. 46, pl. vii. figs. 5, 6.

This coral was dredged by the Challenger in all parts of the world. It varies very much in size and appearance, the smallest specimens obtained measuring 3 mm., and the largest 40 mm. in diameter: the increase in size being evidently not a matter of age and growth so much as of different development under different conditions. A specimen



*Bathyactis symmetrica* (Moseley).
Three times the natural size. Dredged west of Tristan da Cunha Island, from 1900 fathoms. Station 133.

measuring only 5 mm. in diameter has already its full amount of septa. In Pourtalès' specimens, the number of zones of synapticulæ were from four to six. In the very largest specimens they only number about eight. I have figured a long series of specimens on Plate XI., in order to show the various forms assumed. The inspection of the series leaves no doubt as to the identity of the large specimens with the small ones. The very large specimens are excessively thin and fragile, and only a small percentage of them were obtained in an unbroken condition. In some specimens dredged on a siliceous bottom composed of diatom skeletons, the wall is excessively thin and,

towards its marginal region, is perforated by a series of apertures on either side of the costæ, thus resembling somewhat, in the structure of its under surface, the species of the genus *Leptopenus* (Pl. XIV.). When a specimen, hardened in spirit, is decalcified, the wall of the corallum in dissolving in the acid, becomes perforated by a similar series of apertures, yielding first at these spots. The condition of the specimens found on the siliceous bottom is no doubt due in large measure to the small supply of lime available, but thin and fragile specimens were also dredged on a bottom of Globigerina mud (as, for example, at Station 147), and one very large, and not exceptionally fragile specimen, was obtained off Banda Island, on a bottom of volcanic detritus. The larger specimens vary in very much the same manner as the smaller; some have the margins of their septa fused for long distances at their points of junction; others show little fusion of the septal margins. In some specimens (fig. 6), the fusion of the septal margins is very irregular, in one (fig. 7), a spongy outgrowth is developed from the coverings of one of the deltas. In some of the largest specimens there is scarcely any trace of a columella; in others there is a large oval one, composed, as described by Pourtalès, of a membranous expansion, through which the spines project.

In all the larger specimens, the septa are very thin, and are finely sinuous. The synapticulæ are continued as ridges, more or less on the surfaces of the septa. In some specimens (fig. 7), the synapticulæ are very little developed, in others, as in that figured in the woodcut, they are regular, and so prominent, as to divide the interseptal chambers into a succession of small, deep pockets. The wall in the larger specimens is folded into a furrow between each of the costal prominences, and is also finely plicated throughout, the sides of each intercostal furrow being plicated transversely to the length of the furrow with the folds inclined slightly towards the centre of the coral disc on each side of the furrow, to meet one another at its bottom.

After tabulating all the occasions on which this coral was dredged, I cannot succeed in establishing any relation between the size of the specimens dredged, and the conditions of depth, bottom, or temperature. No large specimen was dredged in less than from 200 to 360 fathoms, but from one of those depths, a broken specimen, which must have measured more than 30 mm. in diameter, was obtained. Small, apparently adult, specimens, of the stouter variety, measuring only 9 mm. in diameter, were dredged from such depths as 2440 fathoms, on several occasions. The greater number of very large specimens were obtained from deep water, many being brought up at one haul of the dredge, as at Station 147, in the South Indian Ocean, where twenty or thirty specimens were obtained from 1600 fathoms, curiously enough, all of them large, no young ones being found amongst them.

Diameter of the smallest specimen obtained, 3 mm. Of the largest, 40 mm.

*Bathyactis symmetrica* was found to have a wider range than any other deep-sea coral, being, in fact, apparently universally distributed in deep water. It has also a

wider range in depth than any other animal, occurring in 30 fathoms off Bermuda, and in the East Pacific Ocean at a depth of three miles. It was dredged abundantly at Station 234, from 2900 fathoms, the specimens being large and in full vigour, full of ripe ova. Some specimens appear as if they had been broken and had reunited, or possibly they were when obtained in the act of splitting up into fragments like *Diaseris crispa*, or have a tendency to do so.

As the distribution of this coral is of especial interest, I give an exact list of all the localities at which it was dredged by us :—

### List of Localities.

#### *North Atlantic.*

Station 73. June 30, 1873. About 60 miles distant from Flores Island, Azores. Lat. 38° 30′ N., long. 31° 14′ W. 1000 fathoms.

Station 78. July 10, 1873. Off the Azores. Lat. 37° 24′ N., long. 25° 13′ W. 1000 fathoms.

Station 36. April 23, 1873. On the South-West Bank, Bermuda. 32 fathoms.

Station 56. May 29, 1873. Off Bermuda. 1075 fathoms.

Station 24. March 25, 1873. Off Culebra Island, Virgin Islands. 390 fathoms.

#### *South Atlantic.*

Station 133. October 11, 1873. West of Tristan da Cunha Island. Lat. 35° 41 S., long. 20° 55′ W. 1900 fathoms.

Station 325. March 2, 1876. East of Monte Video. Lat. 36° 44′ S., long. 46° 16′ W. 2650 fathoms.

Station 332. March 10, 1876. Between Monte Video and Tristan da Cunha. Lat. 37° 29′ S., long. 27° 31′ W. 2200 fathoms.

#### *South Indian Ocean.*

Station 147. December 30, 1873. Off the Crozet Islands. Lat. 46° 16′ S., long. 48° 27′ E. 1600 fathoms.

Station 157. March 3, 1874. Between Kerguelen Island and Melbourne, Australia. Lat. 53° 55′ S., long. 108° 35′ E. 1950 fathoms.

*Malay Archipelago and West Pacific Ocean.*

Station 194. September 29, 1874. Off Banda Island. Lat. 4° 33′ S., long. 129° 58′ E. 360 fathoms.

Station 195. October 3, 1874. Between Banda Island and Amboyna. Lat. 4° 21′ S., long. 129° 7′ E. 1425 fathoms.

Station 196. October 13, 1874. East of the Sulu Islands. Lat. 0° 48′ S., long. 126° 58′ E.

Station 218. March 1, 1875. Off the Schouten Islands. Lat. 2° 33′ S., long. 144° 4′ E. 1070 fathoms.

Station 224. March 21, 1875. West of the Caroline Islands. Lat. 7° 45′ N., long. 144° 20′ E. 1850 fathoms.

Station 181. August 25, 1874. South of the Louisiade Group. Lat. 13° 50′ S., long. 151° 49′ E. 2440 fathoms.

*East Pacific Ocean.*

Station 241. June 23, 1875. East of Japan. Lat. 35° 41′ N., long. 157° 42′ E. 2300 fathoms.

Station 244. June 28, 1875. East of Japan. Lat. 35° 22′ N., long. 169° 53′ E. 2900 fathoms.

Station 299. December 14, 1875. Between Juan Fernandez Island and Valparaiso. Lat. 33° 31′ S., long. 74° 43′ W. 1375 fathoms.

## Note on the Structure of the Soft Tissues in *Bathyactis symmetrica*.

When a specimen of *Bathyactis symmetrica*, hardened in absolute alcohol, is decalcified, a thin membrane separates from the entire surface of its base, leaving, before the decalcification is complete, a continuous sheet of calcareous matter beneath it. Thus, when decalcification is complete, this layer is quite free from the soft tissues lying above. The entire membrane is plaited in correspondence with the laminæ and ridges projecting from the under surface of the corallum, and the folds being persistent, the radial markings of the corallum are preserved in it. The membrane is composed of a structureless layer of mesoderm, covered by a layer of ectoderm cells, amongst which there are few or no nematocysts. Above the membrane, and quite free from it except at its margin, the soft tissues are divided into twelve triangular-shaped masses joined to the central stomach by their apices. These triangular masses are composed of radiating elongate masses of soft tissue, four in number in each mass. In each the mass, which at its apex where it joins the stomach is single, splits at a short distance from this into two, and each of the two

radial masses thus derived splits again. Thus, in the entire coral there are forty-eight radially-disposed masses of soft tissue occupying the corresponding septal interspaces. The anatomy of the coral was not followed further, none of the specimens being in very good condition, having mostly suffered from breakage and deliquescence before reaching the surface. Some specimens contained numerous large ova.

### *Cycloseris.*

*Cycloseris tenuis* (Pl. X. figs. 6, *a*).

*Fungia tenuis*, Dana, Zooph., 1846, p. 290, pl. viii. fig. 1.

MM. Milne-Edwards and Haime considered Dana's *Fungia tenuis* from the Pacific Ocean as probably identical with their *Cycloseris sinensis*.[1] *Fungia sinensis* has, however, according to their description, eight complete cycles, whereas Dana's has only six systems, and instead of being circular is subangular. The Pacific species thus seems to be distinct. I figure a specimen dredged off Tongatabu.

Diameter of the corallum, 20 mm. Extreme height from centre of the base to the inner tip of the septa, 5 mm.

Station 172, off Tongatabu, Friendly Islands. 18 fathoms.

## Family Eupsammidæ, Milne-Edwards and Haime.

### *Balanophyllia.*

*Balanophyllia bairdiana*, Milne-Edwards and Haime (Pl. XII. figs. 4–7).

Four specimens, dredged in 40 fathoms off the South Australian coast, seem referable to the above species, of which the type is in the British Museum. Two of the specimens are young, and the other two, though differing in size, apparently adult. The larger adult specimen, on comparison with the type, which is not in good condition, is seen to differ from it in that it has a well marked though very thin epitheca at its base (see fig. 4), the type having almost none at all though adult. The specimen further differs from the type in that its costæ are less prominent and its septa more numerous. The larger of the young specimens very closely approaches *Balanophyllia florideana*, Pourtalès (Deep-Sea Corals, p. 41, pl. iv. figs. 5, 6), a specimen of which is also in the British Museum.

Adult corallum straight, flabelliform or elongate, compressed, conical, with truncated base of attachment much compressed. A thin epitheca present at the base, extending for from one-third to two-thirds the height of the corallum. Costæ close set, covered with fine sharp denticulations, formed in the young coral by double rows of granules, in

[1] Milne-Edwards and Haime, Hist. Nat. des Cor., tom. iii. p. 52.

the adult double only towards the margin of the calicle, simple below. Wall finely perforate all over. Calicle in the adult irregularly elliptic in outline, being angular at the ends of the long axis, the ratio of the axes being 100 to 200; in the young nearly circular. The summits of the smaller axis a little higher than those of the larger axis. Fossa of about one-third or one-fourth the depth of the height of the corallum. Columella spongy, well-developed, flat at the bottom of the fossa, and not at all prominent in it. Septa, in the largest specimen, 112 in number, disposed in the same manner as in many species of *Flabellum* with numerous septa, the irregularity being produced by the development of additional partial systems on either side of the ends of the longer axes of the calicle. Septa slightly exsert according to order. Primaries and secondaries equal, uniting with the columella deep in the calicle. The outer quaternary septa in each half system fuse together over the tertiaries in pairs at their junction with the columella, and their junctions are thickened by processes of the spongy columellar substance. These outer quaternaries in each half system are far larger than the inner, which latter fuse with them at some distance from the columella, and thus bridge over the proximal edges of the single pair of quinary septa present in each half system.

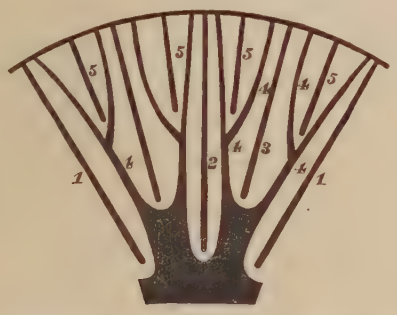



Diagram showing the arrangement of the septa in *Balanophyllia bairdiana*.
The septa of successive orders are indicated by numbers.

The arrangement of the septa in the adult is shown in the accompanying diagram. The fusion of the septa resembles that of *Deltocyathus* and *Stephanophyllia*. Pourtalès remarks on the resemblance of the arrangement in his *Balanophyllia florideana* to that in these two genera.[1] In the younger specimens the fusions of the septa are early marked. At first the tertiary septa are seen to be fused at their inner margins over the secondaries, but as growth proceeds, these fusions are hidden by the increase of the columella and swallowed up in it.

The smaller adult specimen is much longer and narrower in shape than the one figured. It has a more perfectly developed epitheca, a shallower fossa, and in it quinary septa are developed only in one or two systems, and in these not in pairs.

[1] Deep-Sea Corals, p. 42.

Height of the corallum in the larger adult specimen, 16 mm. Extreme breadth, 14 mm. Shorter diameter of the calicle, 8 mm.

Station 162, in Bass Straits, Australia, 38 to 40 fathoms. Three specimens.

Off Port Jackson, New South Wales, 30 to 35 fathoms. One specimen.

*Balanophyllia malaccensis*, Saville Kent, Proc. Zool. Soc., 1871, p. 285.

Station 192. Off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms. A single specimen.

Station 201. Basilan Strait, Philippine Islands. Lat. 9° 3′ N., long. 121° 48′ E. 102 fathoms. A young specimen of the same (?).

*Balanophyllia cornu*, n. sp. (Pl. XII. figs. 11–15).

Corallum curved, elongate conical, somewhat compressed, without any trace of epitheca, attached by a wide-spreading encrusting base, investing dead fragments of the same species. Costæ well marked, close set, broader towards the margin of the calicle and on the surface of the encrusting base, over the entire arc of which they are continued, composed of fine but sharp granules. Wall very finely perforate. Mouth of the calicle oval in outline, somewhat contracted in area by a slight inflexion of the wall at its margin. Ratio of the axes about 100 to 80. The summits of the two axes about on a level. Fossa narrow, bounded by the vertical inner edges of the major septa, deep in the younger specimens, shallower in very old ones, being filled up by the prominent columella. Columella elongate, spongy, standing up prominently, free from the surrounding

Diagram showing the arrangement of the septa in *Balanophyllia cornu*.
The septa of successive orders are indicated by numbers.

septa at the bottom of the fossa. Septa very slightly exsert, in six systems and four cycles, with some septa of a fifth cycle. Primary and secondary septa nearly equal. The quaternary much larger than the tertiary, and closely accompanying the primary and secondary septa in the upper part of their course, diverging from them in the deeper regions of the fossa. The pairs of quaternary septa embracing each of the primaries are larger and more prominent than those adjoining the secondaries. Septa imperforate, with even surfaces beset with fine pointed granules.

The accompanying diagram will serve to explain the arrangement of the septa, which is very badly delineated in the figures in the plate.

All three specimens obtained are attached to fragments of dead coralla of the same species. Two of the specimens, as seen in the figure, are attached together to the wall of a dead larger calicle, their spreading bases are partly confluent at their edges, but the line of demarcation between the two is defined to some extent by the arrangement upon them of the costal striations.

This coral comes near *Balanophyllia gigas* (Brüggeman, unpublished MSS.), from Japan, the type of which species is in the British Museum, and which has a similar prominent columella. In *Balanophyllia gigas* there is, however, a dense epitheca, which is entirely wanting in the present species. *Balanophyllia gigas* is much larger than *Balanophyllia socialis*, but has the same general shape.

Extreme height of the largest specimen, 55 mm. Longest diameter of the calicle 24 mm. Extreme height of the smaller specimen, 25 mm.

Station 192, off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms. Three specimens dredged

*Balanophyllia*, sp. (?)

A single broken specimen of a *Balanophyllia*, with the interior of the calicle entirely hollowed out by decay, was dredged off the Philippines. It is curved, with an irregularly undulate surface, compressed, and attached by a very narrow pedicle. It has well marked and very regular costæ, and no trace of epitheca. I cannot refer it to a species, but possibly it is a variety of *Balanophyllia socialis*.

Height of the calicle, 35 mm.

Station 208, off Gigantes Island, Philippines. 18 fathoms.

*Balanophyllia rediviva*, n. sp. (Pl. XV. figs. 10–12).

Corallum reddish coloured, usually elongate, curved, cylindrical, the upper portion only living, the lower dead and partly decayed, sometimes short and cup-shaped. When elongate, marked by a series of transverse constrictions, marking where rejuvenescence has taken place. Wall finely perforate all over. Composed of fine granules. Primary costæ well marked but slightly prominent sharp ridges, beset with two or three slight dentations; secondary costæ much finer, with three or four denticulations; other costæ scarcely visible (fig. 10*b*). A thin, smooth, glistening epitheca present at the base of the living portion of the corallum. Around the mouth of the old calicle, from which the new growth of the corallum has started, the dentations of the costæ and tips of the exsert septa remain visible through the epitheca slightly prominent. Calicle oval, or nearly circular in outline. Septa in six systems and four cycles. Primary and secondary septa prominently exsert according to order, quaternary septa much more exsert than the tertiaries, sometimes more so than the secondaries, and with their exsert portions fused to the sides of the primaries, against which they lie. The septa consisting of fine imperforate

laminæ, marked with curved accretion lines, and beset with very fine granules. Quaternary septa much larger than the tertiaries, and arranged as in *Balanophyllia socialis*. Fossa narrow and elongate, bounded by the vertical inner margins of the primary and secondary septa, about 6 mm. deep in the single perfect specimen. Columella elongate in outline, prominent in the depths of the fossa, spongy in structure. Composed of several small parallel columns.

Only one perfect and living specimen of this coral was obtained, and from it the characters given above are mainly derived. The other specimens were dead, and much decayed, their outer surface having been removed by corrosion, as well as their septa and columella, of which traces only remain. There can, however, be no doubt that these dead specimens belong to the same species as the living one which was dredged at the same time. The long curved specimen (fig. 11) shows a series of transverse constrictions, marking where the corallum has been lengthened by means of a series of buds or fresh starts of growth, which have always been smaller in the area of their base than the mouth of the calicle from which they sprung, hence the constrictions. There are seven such on the dead elongate specimen. The two short cup-shaped specimens attached together (fig. 12) are closely similar in appearance to this latter, and doubtless belong to the same species, as is borne out by what remains of their septa. They are apparently young ones, which have not yet commenced elongation by budding, though they seem to have grown larger than usual without having done so. Both are attached to a dead fragment of a large specimen of the same species. The smaller one is possibly a lateral bud from the larger.

The coral resembles closely in its habit of growth *Parasmilia fecunda* = *Cœlosmilia fecunda*, Pourtalès,[1] = *Anomocora fecunda*, Studer = *Blastosmilia fecunda*, Duncan.[2] If a new genus be retained for the species, as Professor Duncan advises, his name, *Blastosmilia*,[3] cannot take precedence of Studer's. The present coral, however, though so like *Parasmilia fecunda* in many respects, as figured and described by Pourtalès and Studer, is undoubtedly perforate, and shows its close affinity with the *Balanophyllias* in the peculiar arrangement of its septa, which differs entirely from that in *Parasmilia*.

Extreme length of the longest specimen, 55 mm. Diameter of the calicle, 14 mm. Diameters of the calicles of the smaller specimens, 11 mm. and 9 mm. respectively.

Station 192, off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms. Only four specimens dredged; one only being perfect.

*Balanophyllia parvula*, n. sp. (Pl. XV. figs. 9, 9*a*).

Corallum short, cylindrical, gradually widening towards the mouth of the calicle, attached by a broad, spreading, and encrusting base. Wall devoid of epitheca, finely

[1] Deep-Sea Corals, p. 21, pls. i., iii., vi.

[2] Monatsbericht der K. P. Acad. der Wiss., Nov. 1877, s. 641, fig. 9, *a–f*. Published 1878.

[3] P. M. Duncan, F.R.S., Madreporaria of the Deep Sea, part 2, Trans. Zool. Soc., vol. x. p. 244, part 5, 1878. Read May 1876.

perforate all over, composed of minute granules. Costæ corresponding with the septa, about equal, appearing as narrow tracts of denser coral tissue, well defined by lines of closely-set perforations, which separate them. Calicle oval in outline. Septa in six systems and four cycles, with a few septa of a fifth cycle. Primary septa prominently exsert, with quaternary septa next to them almost equally exsert, and with their exsert portions fused to those of the primaries. Secondary septa exsert to about half the height of the primaries, and with the exsert part of the much smaller adjacent quaternaries partly fused to them. Tertiaries hardly at all exsert. Within the calicle the pairs of quaternary septa adjacent to the primaries are almost as large as these latter, and lying nearly parallel to them, form a prominent figure of six rays within the calicle. The secondaries are very much smaller, and the quaternaries next them in proportion, but still larger than the tertiaries, which are very small. All the septa are finely and irregularly but sharply denticulate at their free margins, and are finely perforated here and there. Fossa conical, not very deep. Columella small, slightly elongate, composed of finely spongy matter.

Extreme height of the largest specimen, 9 mm. Extreme diameter of the same, 8 mm.

Station 201. In Basilan Strait, Philippine Islands. 102 fathoms. Three specimens, two young and one adult.

### *Thecopsammia*, Pourtalès.

*Thecopsammia gemma*, n. sp. (Pl. XV. figs. 8, 8*a*, 8*b*).

Corallum white in colour, straight, subcylindrical, expanding slightly and gradually towards the calicle, attached by a broad base. Epitheca extending over about three-fourths of the surface, rugose in appearance, being transversely pleated and striated, with a sharply defined upper margin. Portion of the wall devoid of epitheca, finely granular in structure and finely perforate all over, certain of the perforations being so arranged in lines as to indicate costæ, which, however, are not at all prominent (fig. 8*b*). Calicle slightly oval in outline. Septa not exsert, the margin of the calicle being almost smoothly rounded, in six systems and four complete cycles, perforated here and there by fine apertures, beset on their surfaces all over with fine sharp granules, denticulate on their rounded margins. The quaternary septa next the primaries larger than the secondaries, and forming with them a six-rayed star within the calicle, not, however, very prominent. Quaternaries next the secondaries larger than the tertiaries. Columella elongate in outline, composed of contorted lamellæ.

Extreme height of the single specimen, 11 mm. Extreme breadth of the calicle, 8 mm.

Station 201. Basilan Strait, Philippine Islands, 102 fathoms.

*Thecopsammia elongata*, n. sp. (Pl. XII. figs. 8–10).

Corallum elongate conical in form, slightly bent and twisted, and here and there somewhat constricted; attached by a narrow base. Epitheca completely covering all but a very small portion of the wall at the margin of the calicle, smooth to the touch in surface, with irregular transverse striations, between which it is dotted over with minute rounded granular projections (fig. 10). Septa in six systems and four complete cycles. Quaternaries larger than the tertiaries. Columella elongate, prominent, spongy in structure.

This coral seems to be by far the largest species of the genus known. The only specimen obtained, which was attached to a *Balanophyllia*, is dead and mutilated. I have, however, founded a new species on the strength of it, since it obviously represents one.

Extreme height of the corallum, 42 mm. Extreme breadth of the calicle, 15 mm.

Station 219, off Nares Bay, Admiralty Islands. 150 fathoms.

*Heteropsammia*, M.-Edw. and Haime.

*Heteropsammia michelini*, M.-Edw. and H.

Numerous specimens, containing as usual a small Sipunculid in their base, were dredged at

Station 212. In Basilan Straits, Philippine Islands. Lat. 6° 55′ N., long. 122° 15′ E. 10 to 20 fathoms.

*Heteropsammia multilobata*, n. sp. (Pl. XII. figs. 1–3).

Corallum compound, with a broad base more or less heart-shaped in outline, bearing from five to seven calicles. Base smooth beneath and flattened, but with a slightly curved or undulating surface. At the narrowed end of the base is the large circular perforation of the commensal Sipunculid, which inhabits a spiral channel excavated within the thickened substance of the base. Edges of the base rounded, smooth. The calicles do not cover the entire basal mass, but leave a wide area of it free all round; their walls rise mostly perpendicularly from its upper surface. Along the upper margin of the basal mass, beneath the bases of the calicular walls, is a row of sharply-defined pores, extending around the entire circumference of the corallum. These pores are probably kept open by the Sipunculid for purposes of respiration; they lead to the cavity it occupies (fig. 2). The base is solid beneath and imperforate, slightly perforate on its sides, and becomes more and more perforate towards the bases of the calicular walls, which latter are finely perforate all over. Regular costæ absent, but a vertical striation is marked more or less all over the sides of the base. Calicles, some more or less confluent, some free, multiplying by fission, elongate or irregularly circular

in outline, with their walls rising to a height of about 3 or 4 mm. above the basal mass. Septa often irregular, owing to the constant fission of the calicles, but in the rounded calicles disposed with more or less regularity in six systems and four cycles, with some septa of a fifth cycle. Quaternary septa prominent and much larger than the tertiaries, which lie far back on the sides of the fossa, sometimes with their inner margins confluent in the deeper parts of the fossa over the margins of the tertiaries. Fossa moderately deep, with a spongy mass at its bottom not at all prominent representing the columella.

This species differs from *Heteropsammia michelini* in no point of importance excepting in being compound. *Heteropsammia michelini* in many specimens shows a tendency in the calicles to divide into two, and *Heteropsammia cochlea* (Spengler), from Ceylon, bears two calicles, sometimes three imperfect ones. I have examined specimens in the British Museum of this species, and it obviously forms a simple stepping-stone between *Heteropsammia michelini* and the present form. It would be absurd to place the present form and *Heteropsammia cochlea* in a genus apart from *Heteropsammia michelini* because of their compound nature. The characters of MM. Milne-Edwards and Haimes' genus must be modified to include compound forms as well as simple. I can find no evidence in the adult coralla of the present species of any remains of a spiral shell within the basal mass. If a shell were originally present, as is quite possible, it has become entirely absorbed. The walls of the spiral chamber occupied by the Sipunculid are composed of bare hard coral tissue. In decalcified spirit specimens, moreover, no trace of any membranous tissue was seen corresponding with the spiral cavity. The Sipunculid was left hanging in a simple spiral cavity excavated within the spongy cœnenchymal mass of soft tissue. Semper, in his account of the *Heterocyathi* and *Heteropsammias* of the Philippines, comes to the same conclusion as to the absence of a spiral shell in *Heteropsammia* and all species of *Heterocyathus*, excepting *Heterocyathus parasiticus*. He says, "the Sipunculid lives always only in a cavity formed by itself in the base of the coral."[1] Semper described in the same paper two new species of *Heteropsammia* obtained by him off the Philippine coast, but curiously enough seems to have met with no compound specimens. He remarks on the interest of Verrill's *Heteropsammia geminata* from Burmah (Amer. Jour. of Science and Arts, vol. xlix., 1870), which has two calicles. Milne-Edwards' two genera *Heteropsammia* and *Stephanoseris* are clearly most closely allied, and should be merged into one. The presence of synapticulæ in the latter genus is a matter of small importance.

Extreme length of the base of the largest specimen, 20 mm. Extreme breadth of the base, 15 mm. Extreme height of the corallum, 16 mm. Diameter of one of the nearly circular calicles, 8 mm.

Numerous specimens dredged. Off Samboangan, Mindanao Island, Philippine Islands. 10 fathoms.

[1] C. Semper, Ueber Generationswechsel bei Steinkorallen, &c., Z. für Wiss. Zoologie, Bd. xxii. 1872, s. 255, u. 264.

### *Dendrophyllia.*

*Dendrophyllia cornigera*, Blainville.

Light and delicate specimens only were obtained. A single fragmentary specimen was dredged together with *Corallium rubrum*.

Off St Jago, Cape Verde Islands, in 100 to 220 fathoms.

A considerable quantity was obtained at

Station 190, in the Arafura Sea. Lat. 8° 56′ S., long. 136° 5′ E. 49 fathoms.

### *Stephanophyllia*, Michelin.

*Stephanophyllia complicata*, Moseley (Pl. IV. fig. 12; Pl. XIII. figs. 3–5).

*Stephanophyllia complicata*, Moseley, Proc. Roy. Soc., 1876, p. 558.

The corallum is circular, free, and without trace of adherence; it has the form of a biconvex lens, the base being very slightly curved, and the upper surface greatly so. The under surface, or wall, is perforated by rows of oblong holes arranged in regular series along the interspaces between the costæ. The costæ are fine ridges covered with small swellings and granules, which radiate out with great regularity from the centre of the basal disk; they commence in the centre from six very short roots of origin, which immediately bifurcate, thus becoming twelve. The bifurcation of each of the costal ridges proceeds at successive distances from the centre, until at the margin of the adult coral there are ninty-six costæ present, sixteen in each system. The costæ at the margin of the calicle are slightly grooved, showing a tendency to divide again. The perforations between the costæ form about twenty-two concentrically-arranged rows. The coral is very convex above the septal meshwork, rising in an even curve which culminates at the columella. There is scarcely any central fossa. There are six systems of septa and five cycles. The primary septa are thin straight lamellæ with untoothed margins, which proceed directly from the periphery to the base of the columella. At about half their length from the periphery to the centre of the calicle is a notch followed by a sudden rise, which forms thus a distinct palus, from the summit of which the line of the inferior margin of the septum slopes sharply down to the base of the columella. The secondary septa are also straight thin laminæ; they can be traced in the adult coral no further than for about one-third the distance from the periphery to the columella, since they are here covered by the tertiary septa, which, bending over the secondary septa at this point, bring together their upper margins, and, fusing with one another, form stout laminæ, which run in a radial direction to join the columella, and are the stoutest and most conspicuous septa in the coral. From their point of junction with the secondary septa, the tertiary septa curve outwards towards the primary septa on either side in each system; and each of them being joined on its side next the primary septa by a curved quaternary

septum, curved lines of septal matter are formed which are fused by short, transverse, synapticular laminæ to the primary septa, at points very near the centres of the lengths of each of these. Thus is brought about the peculiar arrangement which forms the most striking feature presented by the adult coral, and which consists in the presence around the elongate columella of six symmetrically arranged oval hollow spaces, each of which is enclosed by a loop-like lamina, as it were, of hard tissue, and bisected longitudinally by the inner end of the palus of the corresponding primary septum.

Shows the arrangement of the septa in the adult and young *Stephanophyllia complicata*. The specimens were taken September 26, 1874, in 129 fathoms, off the Ki Islands.

A. Adult, diam. 1·7 cm. B. Young, diam. 6 mm.

In their further course, the tertiary septa are bent from side to side in a most remarkable manner, and fusing at successive distances outwards with the shorter quaternary and still shorter quinary septa, which are likewise extremely undulate in their course, a series of chambers is formed, which chambers are closed at their peripheral ends by processes of synapticular matter. The chambers are arranged symmetrically in each system on either side of the secondary septum, and successively decrease in size and increase in number from the centre outwards. The chambers opening all over the coral give it a most remarkable honeycombed appearance.

The columella is an elongate, thin, vertical lamina stretched in line with an opposite pair of primary septa. At its base it is provided with rootlets, which join the primary and fused tertiary septa.

In a young specimen of this coral, without reference to which the true nature of the complicated structures in the adult could hardly have been determined, the corallum is almost symmetrically biconvex and perfectly circular; but the columella is elongate, as in the adult. The columella is papillar rather than laminar, and represents the rooted base of the adult columella. There are sixty perfect costæ present at the margin of the calicle, and the commencement of two more in each system (*i.e.*, twelve in all). There are twelve concentric rows of perforations in the base. The septa are not nearly so much contorted as in the adult, and the synapticular junctions between them not being as yet formed, the division of the septal cavities into successive chambers is not apparent as in the adult. No superficial fusion of the primary with the curved extensions of the tertiary and quaternary septa has as yet taken place; hence no six-rayed star or flower appears in the centre. Stout transverse granular projections are present on the upper margins of the septa, the sources of future synapticular connections. Only four cycles are complete in each system. Two members of the fifth cycle are present in each system, and are those nearest the primary septa on each side. An additional pair of quinary septa is just commencing to grow in each system, and branching off from the peripheral ends of the quaternary septa which are next the secondary, but on that side of them which is nearest the primary, *i.e.*, opposite to the secondary. A very short branch of the costa belonging to the interspace between the quaternary and secondary septa passes into each interspace formed between these newly-grown quinary septa and the quaternary adjoining.

In the development of a flower-like series of oval chambers around the elongate columella, this coral most strikingly resembles *Stephanophyllia florealis* of Quenstedt,[1] which is a fossil of the "White Jura" (=Oxford Clay) formation. The oval chambers here in the first series around the columella are twelve in number, and alternate with twelve in the second series. In *Stephanophyllia complicata*, six alternate with six. In *Stephanophyllia florealis* there appears to be no trace of the bisection of these chambers by the straight primary and secondary septa as in *Stephanophyllia complicata;* but the fossil specimens are, according to Quenstedt, always so much mutilated that their structure can only partially be made out. Possibly the twelve chambers of *Stephanophyllia florealis* may represent the twelve of *Stephanophyllia complicata*, formed by the bisection of the six inner by the primary septa, which might appear as figured in *Stephanophyllia florealis* in much-worn specimens. Comparison with actual specimens may determine this point. In *Stephanophyllia florealis* forty-eight septa only are distinguishable; but it is highly probable that structures so slight as the quinary septa of *Stephanophyllia complicata* might be indistinguishable in a mutilated fossil. The coral appears to fall into that division of the *Stephanophyllias* distinguished by Milne-Edwards as having the

[1] Milne-Edwards and Haime, judging from Quenstedt's figure, Handb. der Petrefact, p. 657, pl. lix. figs. 12, 13, 1852, wrongly supposed that *Stephanophyllia florealis* should be referred to the genus *Thecocyathus*, Hist. Nat. des Coral. t. ii. p. 49.

secondary septa smaller than the tertiary, and in which the tertiary septa fuse together in front of the secondary, which do not reach the centre. The coral, in fact, resembles *Stephanophyllia suecica*, a fossil from Ignaberga, Sweden; but in this coral the columella is rudimentary. On the other hand, Quenstedt's *Stephanophyllia florealis* has been supposed by Milne-Edwards to be Turbinolid, and allied to the genus *Thecocyathus*.

*Stephanophyllia complicata* perhaps comes nearest to *Stephanophyllia discoides* of Milne-Edwards and Haime[1] from the London Clay. It differs in having a laminate columella. In *Stephanophyllia discoides* the columella is papillose and circular. In *Stephanophyllia nysti* (M.-Edw. and H.), from Miocene formations at Antwerp, there is a similar fusion of septa to that occurring in *Stephanophyllia complicata*; but in this species the columella is almost absent.

Dimensions: of an adult specimen—extreme diameter, 1·7 cm.; extreme height from the summit of the columella to the centre of the base, 7 mm. Of the young specimen—extreme diameter, 6 mm.; height, 3·5 mm.

Station 192, off the Ki Islands. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms. Only two specimens, one adult the other very young.

*Stephanophyllia formosissima*, Moseley (Pl. IV. fig. 11; Pl. XIII. figs. 6, 7; Pl. XVI. figs. 8, 9).

*Stephanophyllia formosissima*, Moseley, Proc. Roy. Soc., 1876, p. 561.

The corallum is discoid, with the base flat in the centre and slightly curved towards the margin. It is white, and very light and fragile, much more so than in *Stephanophyllia complicata*, being composed of a fine trabecular network, through which the light penetrates freely, as through a fine sieve, when the coral is held up to it. The base is composed of a series of fine, radiating, costal rods connected by transverse trabeculæ, which have a general concentric disposition. The septa are composed, like the remainder of the corallum, of fused trabeculæ; but these are stouter than those composing the base, and more perfectly fused, so as to form, in most regions, continuous plates pierced by rounded perforations. There are six systems of septa and five cycles. The upper margins of the septa rise in a curve from points distant a short space from the margin of the calicle, and, ascending to some height above the leval of the base, sink down again internally to the wide, oval fossa occupied by the columella. The primary and secondary septa are straight. Their upper margins lie at a lower level than those of the remaining septa, and are only very slightly toothed. The primary septa are free from adherence. The margins of the tertiary, quaternary, and quinary septa are deeply dentate, the teeth being curved towards the columella. The quinary, quaternary, and tertiary septa fuse with one another laterally and by their upper margins at successive distances from the

[1] MM. Milne-Edwards and Haime, British Fossil Corals. London: Palæontological Soc., 1850-54, part 1, p. 34, pl. ii. fig. 3.

periphery of the corallum forming six deltoid masses of septa. The tertiary septa forming the sides of these deltoid masses are bent over, sloping away from the primary septa, so that at the apex of the delta the upper margins of these tertiary septa use and cover over the inner ends of the secondary septa. There is no separation of the septal interspaces into chambers as in *Stephanophyllia florealis* by development of synapticulæ; but the quaternary and quinary septa are more or less bent over above, so as to fuse along part of their upper margins and roof in the spaces between them. The septa correspond to the interspaces between the costæ. The columella is a large oval spongy mass composed of fine trabeculæ.

In the living animal the disc is of a madder red colour, much darker towards the margin of the calicle, where it is marked by vivid green emerald stripes, which pass on either side of the bases of the outer tentacles. The margin of the mouth is white. The corallum is conspicuously white, and since the coloured parts of the soft tissues do not extend to its very margin, the tissues being there scanty and transparent, this margin shows out as a white zone surrounding the dark coloured central parts of the coral. The tentacles are conical, with rounded knobs at their tips. Their arrangement is shown in figures 8 and 9, Plate XVI. Tentacles of five orders in size are to be distinguished disposed symmetrically at regular intervals from the centre of the disc. Nearest the mouth, at about two-thirds the distance from the centre of the disc to the margin of the corallum, is a circlet of six tentacles situated over the primary septa. A distinction of six primary tentacles from the rest by position is not uncommon in corals, even where the distinction between primary and secondary septa is not much marked. A similar disposition of tentacles occurs in the deep-sea genus of Actiniadæ *Corallimorphus*, (Moseley).[1] A zone of six somewhat larger tentacles succeeds this at a little distance nearer the margin of the corallum; these tentacles are placed over the secondary septa. A zone of twelve smaller tentacles succeeds these, being placed on the septa adjoining the secondaries on either side. In addition three more still smaller tentacles intervene between each primary and secondary septum. There are sixty tentacles in all. The tentacles of the inner zones are white, with dark madder tips, the outer smaller tentacles of a light madder colour. The fresh specimens obtained, both off the Ki Islands and off the Philippine Islands, agreed closely in their colouring in all details. There are in the Turin Natural History Museum specimens of a *Stephanophyllia* from Ligurian Miocene deposits which closely resemble those of this species. *Stephanophyllia elegans* (Michelin) is evidently very near the present species, but in it the septa are much higher at their outer ends, and more completely fused together.

Extreme diameter of the largest specimen, 39 mm. Extreme height, 11 mm. Smaller specimens measure 25 mm. and 20 mm. respectively.

[1] On New Forms of *Actiniaria* Dredged in the Deep Sea, with a Description of certain Pelagic Surface Swimming Species, Trans. Linn. Soc. Lond., 2d ser., Zoology, vol. i. p. 299.

Station 192, off the Ki Islands. Lat. 5·42° S., long. 13·2° 25′ E. 129 fathoms. Three specimens.

Station 209, off Zebu, Philippine Islands. Lat. 18° 10′ N., long. 123° 55′ E. 95 fathoms. Several specimens.

### Notes on the Structure of the Soft Tissues of *Stephanophyllia formosissima*.

When decalcified the coral yields a plump tough mass corresponding exactly in shape with that of the hardened coral before the removal of the calcareous support. A continuous layer of soft tissue does not, as in the case of *Bathyactis symmetrica*, separate off from the inferior surface of the coral, and hang loose unattached to the structures above it. The whole is compact and elastic, and returns to its original form after compression. It may be cut in any direction without falling to pieces. The inferior surface of the decalcified mass presents a radiate structure closely corresponding in appearance to that seen on the under surface of the corallum. Five ridges of soft tissue radiate out from the centre, increasing in number by division, with regularity at definite distances from it, and gradually becoming thicker towards the margin of the coral. These ridges of tissue occupy in the recent coral the intervals between the costæ, and thus correspond in position with the septa. The inferior edges of the mesenteries correspond in position with the costæ.

The ridges of soft tissue lying in the intercostal grooves of the corallum are connected together by series of transverse trabecular prolongations of the mesoderm which, passing through the perforations in the base of the corallum lying on either side of the inferior edges of the septa (Pl. XVI. fig. 5), join the bases of the mesenteries where these lie above the costæ. Thus, by means of this series of trabeculæ of soft tissue, the various complex ramifications of the general mass are held together, and hence the compactness and elasticity of the whole decalcified coral, as opposed to the loose and disconnected condition of that of such a form as *Bathyactis symmetrica*. Masses of contorted trabecular mesoderm are developed throughout the coral corresponding in position with the ramifications of the porous corallum, and a large spongy mass of this nature remains behind after decalcification in the place of the columella.

The appearance presented by the decalcified coral, when laid open by a vertical incision, is shown in figure 9, Plate XVI. A short simple alimentary tube leads to a wider cavity bounded by the free borders of the mesenteries with their attached filaments. The mesenteries of the most inferior order spring from the upper body-wall of the coral (corresponding with the membrane forming the disc in *Flabellum*) near its margin, and thence are stretched to join the basal soft structures and columella. These mesenteries are very narrow, and their free border is only very slightly curved. The mesenteries of successively higher orders are broader and broader, have a longer stretch

of attachment to the under surface of the upper body-wall, and have their free border more and more curved. The mesenteries of higher order are attached to the outer surface of the alimentary tube. The mesenteries are all perforated by several irregularly oval apertures traversed in the recent coral by spines and calcareous trabeculæ projecting from the faces of the septa. The mesenteries are provided with well-developed muscular slips, which have rather a complicated arrangement within the major mesenteries. Near the summits of these mesenteries the muscular fibres are directed nearly horizontally outwards, stretching directly between the line of attachment of the mesentery to the alimentary tube and the upper wall of the body. In the lower part of the mesentery the fibres are disposed in curved lines crossing one another, but with a general downward direction towards the base. Some of these vertical fibres are continued upwards so as to cross the horizontal ones above them just described to some little extent, as shown in the figure. The inferior border of the mesenteries overlies in the recent coral the costal trabeculæ as already described; hence in a vertical section of the decalcified coral, such as shown in the figure, a groove or hollow is seen beneath the lower border of the mesenteries, left by the removal of the costal calcareous trabeculæ. The lower borders of the mesenteries are attached to a series of processes of soft tissue which join the basal ridges of soft tissue lying between the costæ. This series of processes is seen in the figure at the base, and the processes are seen to be separated from one another by a series of apertures, through which, in the recent coral, passed the calcareous trabeculæ seen in figure 5, Plate XVI. It is to this series of processes that the vertical muscular fibres of the mesenteries are attached. They are gathered towards the lower borders of the mesenteries into a series of distinct bundles which pass down into these processes, and hence the muscular arrangement towards the lower borders of the mesenteries appears very complicated to the eye. Towards the inner regions of the lower parts of the mesenteries some muscular fibres are directed almost horizontally inwards towards the columella.

Most of the major mesenteries in the single specimen dissected bore large ova and embryos at the upper parts of their free margins. Some of the embryos were in an advanced stage of development, but were so far contracted by the action of reagents that their form could not be satisfactorily made out; nor could it be determined whether they were free in the mesenterial chambers or still attached. In nearly all the mesenterial cavities were found one or two small crustacea (a Gammarid ?), which must apparently live as commensals within the cavities of the living coral.

### *Leptopenus*, n. gen.

Corallum discoid, excessively thin and fragile, with the wall so completely covered by perforations as to resemble lace-work, being built up of a network of delicate radiating and circumferentially-directed trabeculæ. Perforations placed at regular intervals

between the costæ, and each divided into two by the septa which alternate with the costæ. Septa, except the primaries, which are free, coalescing successively according to order, and forming deltoid figures, beset with a series of long outwardly-directed spines on their free margins; attached beneath to the transverse trabeculæ which separate from one another the perforations of the wall by a series of short processes, in the intervals between which their lower margin is free. Columella large, spinous. Animal provided with knob-bearing tentacles.

I have founded this genus to contain two very remarkable corals, dredged in deep water, which are so fragile that it is astonishing that they arrived at the surface in such good preservation as that in which they were obtained. The two species differ markedly from one another, but have so many fundamental agreements that they must evidently be placed in the same genus. They are evidently closely related to the *Stephanophyllias*, but their corallum is so perforate as to be reduced to a mere lace-work. No corals immediately like them appear to have been procured before, or since, either in the recent or fossil condition. Specimens belonging to the genus were dredged on four occasions, all from deep water (over 1500 fathoms), and all in the Southern Hemisphere.

*Leptopenus discus*, n. sp. (Pl. XIV. figs. 1–4; Pl. XVI. figs. 1–7).

Corallum white, discoid, flat, excessively thin; its greatest height, which is in its centre measured to the top of the columella, being not more than 2 mm. Base consisting of a network composed of a series of long, delicate costal trabeculæ radiating from its centre. These radiating trabeculæ bifurcate at regular intervals, and the number of them thus regularly increasing from the centre of the disc outwards, they terminate at the margin of the disc in a series of pointed spinous projections seventy-two in number.[1] The notches between these marginal spines are not all equally deep, but those between every alternate pair are deeper. The less deep notches correspond with the major septa in position. The radial trabeculæ are connected at regular intervals by a series of transverse narrow rounded bars of calcareous matter, which divide the spaces enclosed between the radial trabeculæ into a series of transversely elongate, oval, or reniform apertures. These elongate apertures are transversed above in their centres by the under edges of the septa, and thus appear on the upper surface of the disc as pairs of perforations. There are about twenty-four or twenty-five apertures in each radial interspace between the centre of the disc and its margin. The wall of the disc is slightly radially pleated, so that each of the costal trabeculæ is made prominent beneath; whilst on the surface, the middle lines of the intervals between these trabeculæ, corresponding with the lines of attachment of the septa, are thrown upwards to about the same extent.

Near the margin of the disc, between the bases of the marginal spines, a small amount of excessively thin laminar matter representing true wall substance is developed

[1] In the figure Plate XIV. figs. 1 and 2, seventy-one only are, by an error of the artist, indicated.

here and there in patches. The septa are in six systems and four cycles, with part of a fifth cycle. The primaries are free from the periphery to the columella, and straight, and consist of very thin laminæ; the secondaries are free to near the columella, where they are covered over by the fused tertiaries, which in joining form a thin laminar expansion over them. The tertiaries bifurcate at a short distance from their junctions, which is equal in all the systems, and the two septa thus derived from each of them themselves bifurcate at a further distance again from the columella, which distance also corresponds symmetrically in all the systems. At each of the bifurcations there is a certain small amount of laminar hard tissue developed covering over the interval in the fork. In each system one of the four septa derived from this last-mentioned bifurcation, namely, that which lies second away from each primary septum, has developed on its side next the secondary septum a small and short additional septum (Pl. XVI. figs. 3, 4). The septa are extremely low, their lamellæ not rising more than 1 mm. above the level of the base of the corallum near its centre, and gradually becoming lower towards the margin of the calicle, before reaching which they become lost (Pl. XVI. fig. 6). They are excavated below by a series of notches (Pl. XVI. fig. 7), which correspond to the perforations in the wall of the base, and are seen from beneath in Plate XVI. fig. 5. Between these notches are a series of short processes of the laminæ of the septa, by means of which the septa are fused to the transverse trabeculæ connecting the costæ already described (Pl. XVI. fig. 3). The free margins of the septa towards the margin of the disc are slightly and irregularly dentate. Towards the columella they bear a series of long but very delicate spines, which are all directed outwards at an angle, and are arranged on the septa at definite intervals with great regularity (Pl. XVI. figs. 2 and 7), increasing in size towards the margin of the disc. Each of the primaries bears six of these spines, each of the secondaries five, three of which project through the laminar expansion found at the junction of the tertiaries over the secondaries. There is a spine at the point of bifurcation of the tertiaries, and other spines disposed close to these as shown in the figure. A few very small and short similar spines compose the columella. The whole group of spines is confined to the central region of the disc, and is seen to rise from it like a cluster of small prickles when the corallum is viewed edge-wise (Pl. XIV. fig. 3).

The septa correspond in position with the intervals between the long spikes into which the margin of the disc is prolonged, and to the intervals between the costæ. The bifurcations of the costæ and those of the septa above them do not correspond in position or arrangement, as will be seen from Plate XVI. fig. 1. The primary and secondary septa do not branch at all, whereas the costæ commence growth at the centre of the disc as six, and almost immediately become twelve by bifurcation. Two of the twelve costæ thus derived in each system, those next the primaries, soon branch again, whilst the pair accompanying the secondary septa do not branch for a considerable distance further away from the centre of the disc. By branchings at successive intervals four costal trabeculæ

are derived from the main branches next the primary septa, whilst only two are derived from those next the secondaries. A distinct deltoid arrangement is observable in the disposition of costal trabeculæ. The outer trabeculæ next the primary septa are straight or nearly so for their entire length, running parallel to and close beside the primary septa; all their branchings appear to occur on their sides lying next the secondaries. Thus each system is complete in itself, and more or less separate both above and below in the corallum; the crossings of the costal trabecula under the septa, necessitated by their different mode of branching, are confined to the interior of each system. So regular are the bifurcations of the septa that I am at a loss to designate the quinary, quaternary, and tertiary septa in each system as such, the terms would seem hardly to apply. The costal trabeculæ appear to grow first in the development of the coral, as is shown by the projection of them at the margin, without corresponding septa developed as yet above them.

The animal of the present species is flat and discoid, and of very small elevation except around the mouth, which is elevated at its margin above the disc (Pl. XVI. fig. 4). The tentacles are elongate, conical in form, with large rounded knobs at their tips. There are six small but long tentacles placed upon the disc at about one-third of the distance from the margin to the centre, and over the primary septa. At the margin of the disc there are tentacles of two sizes, larger and smaller, which alternate with one another, the smaller being placed at a slightly higher level on the edge of the coral than the larger, which lie in the same place as the disc itself. There are twelve marginal tentacles, six large and six small, in each system. The tentacles correspond in position to the intervals between the marginal spines that is to the lines of the septa. The larger tentacles correspond to the intervals between the marginal spines which are least deeply indented. The tentacles are probably absolutely non-retractile. The entire disc of the animal to its very margin, which coincides with the tips of the marginal spines, was coloured, in a fresh specimen examined, dark madder; the mouth was of a light orange colour; the tentacles transparent and colourless, with opaque white tips. The thread cells in the knobs of the tentacles were found to be of a similar form to those occurring in the tentacles of *Corallimorphus profundus* (Moseley) of the very elongate cylindrical form.[1]

Extreme diameter of the fresh animal between the tips of the tentacles, 38 mm. Extreme diameter of the corallum, 25 mm. Extreme height from the centre of the base to the tips of the spines of the septa, 2 mm.

Four specimens in all of this coral were obtained on three occasions in deep water in the Southern Atlantic and South Indian Oceans.

Station 147, in the Southern Indian Ocean, 80 miles west of Hog Island, Crozette Islands. Lat. 46° 16′ S., long. 48° 27′ E. 1600 fathoms.

[1] H. N. Moseley, On New Forms of *Actiniaria* Dredged in the Deep Sea, Trans. Linn. Soc., 2 ser., Zoology, vol. i. p. 300.

Station 157, in the Southern Indian Ocean, in about the latitude of Heard Island, but far to the east of it. Lat. 53° 55′ S., long. 108° 35′ E. 1950 fathoms.

Station 323, South Atlantic Ocean, east of the Rio de la Plata. Lat. 35° 39′ S., long. 50° 47′ W. 1900 fathoms.

*Leptopenus hypocælus*, n. sp. (Pl. XIV. figs. 5, 6).

The corallum is, as in the last species, discoid, but is concave beneath, and correspondingly convex above. The corallum is constructed in a closely similar manner to that of the preceding species, excepting that the perforations of the base are larger and more regular in arrangement, and that the trabeculæ composing the network between them are finer and more delicate. The margin of the disc is circular, with forty-eight very short and equal projections placed on it at equal intervals, and corresponding in position to the costal trabeculæ, of which there are a like number. The septa are much higher than in the last-described species. They are in six systems and four cycles, with rudiments of a partial fifth system. The primaries are free, whilst the remaining septa form deltoid masses. The fork formed by the tertiaries at their junction and union with the secondaries is covered in by a large area of curved laminar matter, which is extended on to the fork formed by the divergence of the outer quarternaries in each system from the tertiaries. The secondaries are continued straight to the margin of the disc, and do not branch. The tertiaries bifurcate near the margin of the disc, a small laminate expansion being developed at the fork, and the outer quarternaries in each system bifurcate also slightly somewhat farther out, thus adding septa which may be considered as part of a fifth cycle. All the septa bear long spines on their margins. From the secondary septa, at the point where they are lapped over by the laminæ in the forks formed by tertiaries, spring six very long and stout spines, one from each septum, which are directed outwards at an angle of about 45° with the horizontal plane of the corallum; beneath these monster spines, which are the only ones borne by the secondaries, these septa have smooth and even incurved free margins, which are continued up on to the spines beneath, and act as struts and supports to them. All the other septa bear spines, but much smaller ones than those of the secondaries, and much more delicate, being long and spicular-like, but all directed outwards at about a similar angle. The columella is composed of a few similar spicules connected together by lamellar matter.

Extreme diameter of the corallum, 20 mm. Extreme height from the basal plane to the centre of the columella, 5 mm.; to the tip of one of the long spines of the secondary septa, 9 mm. Length of one of the spines, 7 mm.

Only one specimen was obtained from a great depth.

Station 299. S.E. Pacific Ocean, off Valparaiso. Lat. 33° 31′ S., long. 74° 43′ W. 2160 fathoms.

# EXPLANATION OF THE PLATES.

## HYDROCORALLINÆ—I. to XIV.

*Note.*—The greater part of the figures relating to the soft structures of the Hydrocorallinæ have been prepared so as to represent by means of ideal sections the conclusions as to structure arrived at by prolonged study of long series of preparations. It would have been impossible to give facsimile drawings of all the preparations from the study of which facts of importance were arrived at, and thus to lay the evidence before the reader in a pictorial form. The practice of illustrating scientific papers treating of minute anatomy by figures which profess to be facsimiles of preparations, and in which often all defects due to breakage of sections or obliquity of the line of cutting are reproduced, seems to me much to be deplored, and only tends to create confusion and needlessly increase the number of figures without in any way enhancing the credit which will be given to the results. The drawings can never be so accurate as to stand in the place of preparations; they will always represent to some extent the author's views as to what is to be observed in the preparations. It seems far better that in the modern stage of the science of finer anatomy, drawings should represent the results attained, in as complete and concise a form as can be devised, so as to convey these results to others almost at a glance, if possible.

In the present figures all the histological details, as well as the major features of the structures represented, have been drawn accurately to scale by means of a series of micrometric measurements. The amount of magnification in diameters is given at the bottom of each plate or figure. Since in the majority of the plates ideal sections through complex canal meshworks are represented, the canals composing the meshworks are necessarily shown as cut open in all directions.

### PLATE I.

Drawings of the cœnostea of the several species of Stylasteridæ of which the corresponding soft tissues are described.

Fig. 1. *Sporadopora dichotoma.* Young vigorous specimen which was obtained in the living condition. Natural size.

Fig. 2. *Sporadopora dichotoma.* Older specimen reduced in size to one-half of its dimensions to show the method of branching in the more fully grown specimens.

Fig. 3. *Spinipora echinata.* Enlarged to twice the natural size.

Fig. 4. *Astylus subviridis.* Several of the branches of the specimen are broken off. Natural size.

Fig. 5. *Stylaster densicaulis.* Portions of a cœnosteum of the natural size. *a* Portion of a tip of a branch enlarged.

Fig. 6. *Allopora profunda.* Natural size. *a* Portion of same enlarged.

Fig. 7. *Errina labiata.* Natural size. The form of the stem of the cœnosteum is much distorted in places by parasitic annelids. *a* Portion of a branch enlarged.

## PLATE II.

Fig. 1. Section vertical to the surface of cœnosteum of *Sporadopora dichotoma* showing the structure of the hard parts. The general mass is seen to be excessively porous in appearance, being traversed in all directions by canals which, in the recent condition of the coral, contain the elements of the cœnosarcal meshwork. The perforations and canals are smaller towards the surface of the cœnosteum, and coarser in the deeper regions. The cavities in the mass occupied by the zooids and gonophores are excavated within it, and have their walls freely perforated, like the remainder of the cœnosteum.

G Z. Mouth of a gastropore.

S. Style terminating above in a delicate brush of spicules.

T. Thin calcareous tabula.

D Z, D Z. Pores of large and small dactylozooids.

G. Cavity or ampulla occupied by a male gonophore, which is in this genus entirely sunken beneath the surface of the cœnosteum.

Fig. 2. View of the surface of the cœnosteum of *Sporadopora dichotoma* as seen by reflected light.

G Z, G Z. Mouths of gastropores.

D Z, D Z. Mouths of dactylopores.

G, G, G. Shallow depressions in which the ampullæ open to the surface.

Fig. 3. Portion of the cœnosteum forming a single calicular system of *Stylaster densicaulis* laid open by a vertical incision, in order to show the arrangement of the hard parts, and enlarged.

G Z. Gastropore.

S. Style of the gastrozooid.

A. Circlet of small rough projections of the cœnosteum, which stand out from the wall of the gastropore just above the top of the style.

D Z, D Z. Dactylopores of the cyclo-system.

P. Walls of the cœnosteum separating the adjacent dactylopores from one another, the pseudosepta of the cyclo-system.

S′. Style of a dactylozooid. This is seen adhering to the outer wall of one of the dactylopores, which is laid completely open in order to show it *in situ*.

Fig. 4. Portion of the cœnosteum of *Spinipora echinata* enlarged to show its outward form. The cœnosteum is covered with long grooved spines, which carry the larger dactylozooids. On the sides of these spines, and about their bases, are numerous simple or slightly lipped smaller pores, occupied by a smaller form of dactylozooid. Deeper in between the bases of the spines lie the pores of the gastrozooids, provided each with a style.

D Z, D Z. Pores of the larger dactylozooids, appearing as grooves in the long projecting spines.

D Z′, D Z′. Pores of the smaller dactylozooids.

G Z, G Z. Pores of the gastrozooids.

Fig. 5. Portion of the cœnosteum of *Labiopora antarctica* much enlarged. From a drawing by Mr Charles Stewart, F.L.S.

G Z, G Z. Pores of gastrozooids with their styles just visible in their depths.

D Z, D Z. Pores of larger dactylozooids.

D Z′, D Z′. Pores of dactylozooids of the smaller kind.

Fig. 6. View of one of the inner surfaces of a fragment of the cœnosteum of *Distichopora coccinea*, which has been split in half through the line formed by the pores of the gastrozooids; showing the arrangement of these pores, and their very long styles.

G Z, G Z. Pores of gastrozooids.

G Z′. Young similar pore which has as yet little depth.

S, S, S. Styles; that on the extreme left remarkably long.

Fig. 7. Somewhat diagrammatic view of a zooid system of *Cryptohelia pudica*, divided vertically in half by a section passing through the axis and in the direction of the length of the branch on which the system is situate. The dotted areas indicate cut surfaces of calcareous substance, the structure of which is not filled in in the drawing. The gastropore consists of two portions, an upper and a lower, separated from one another by a circular constricted aperture. The wall of the upper portion ends below in a thin incurved border bounding the circular aperture, and from

the border behind this wall all round a narrowed prolongation of the lower chamber of the gastropore passes up, and leads above by a series of offsets to the lower terminations of the tubular portions of the dactylopores, conveying, in the recent condition of the coral, the main canals springing from the gastropore. The support of the lid of the pore system sends a stout prolongation downwards to fuse with the wall of the upper chamber of the gastropore.

G P. Upper chamber of the gastropore.

G P′. Lower chamber of the gastropore.

D P, D P. Dactylopores.

C. Space behind the wall of the upper gastropore chamber leading to the dactylopore tubules.

L. Lid covering the cyclo-system.

Fig. 8. Pore system of *Astylus subviridis* laid open by a vertical incision through the axis and in the direction of the length of the supporting branch.

G P. Upper chamber of the gastropore.

G P′. Lower chamber of the gastropore.

B. Tongue-like process of the lower border of the wall of the upper chamber of the gastropore, which projecting horizontally in the direction, in each system, of the tips of the branches, converts the aperture leading between the two chambers into the form of a horseshoe.

A. Base of the tongue-like process and part of the wall of the upper chamber cut through.

C C. Space behind the wall of the upper gastropore chamber, leading, as in the last figure, to the dactylopores.

G, G. Ampullæ.

Figs. 9–16. Diagrammatic representations of the arrangements of the gastropores and dactylopores in the several genera of Stylasteridæ, to show the manner in which cyclo-systems and their pseudosepta have become developed in this family.

The following letters apply similarly throughout the series :—

G Z. Gastropore.

S. Its style.

D Z. Dactylopore.

Fig. 9. *Sporadopora dichotoma.* The pores of both kinds are irregularly scattered over the surfaces of the cœnosteum.

Fig. 10. *Allopora nobilis.* A number of dactylopores are grouped in a circle around a single centrally placed gastropore.

Fig. 11. A system of pores from another part of the same specimen of *Allopora nobilis*. Shallow grooves run from the central gastropore to the encircling dactylopores, a cyclo-system being thus commenced.

Fig. 12. Horizontal section through the foregoing group at a slight depth from the surface to show the existence of styles in the pores of the dactylozooids.

Fig. 13. *Allopora profunda*. The connecting grooves between the pores of the cyclo-system are deeper. The system is regular, and the interval between the dactylopores have all the appearance of septa.

Fig. 14. *Allopora miniata*. (Copied from Pourtalès, Deep-Sea Corals, pl. iii. fig. 16.) Here the styles of the dactylozooids are brush-like in form, just like those of the gastrozooids.

Fig. 15. *Astylus subviridis*. There are no styles present in either kind of pore. The pseudoseptal system is complete. The open mouths of the tubular continuations of the dactylopores appear as a circlet of circular openings at the bottoms of the wide pseudo-interseptal spaces. The gastropore has two mouths, an upper circular and wider one, and a deeper constricted opening, which is rendered horseshoe-shaped by the projecting tongue of calcareous matter B.

Fig. 16. *Distichopora coccinea*. The pores are entirely confined to the central lines of the sides of the branches of the flabelliform coral. The pores here occur in regular straight rows. The gastropores form a median row, and on each side of this is a single row of dactylopores, the mouths of which are elongate in form with their longer axes directed towards the gastropores.

## PLATE III.

Section vertical to the external surface of the decalcified living lamina of *Sporadopora dichotoma*.

The main mass is seen to be composed of a network of ramifying and freely anastomosing canals. The canals are of larger diameter towards the base of the section, where they are continuous with the body cavities of the zooids; but in the most inferior region they are again smaller, being here somewhat atrophied and effete. Towards the outer surface of the coral the canals are of smaller diameter and enclose smaller interspaces than the larger deeper canals. The interspaces throughout the meshwork are, in the recent condition of the coral, filled by the calcareous cœnosteum.

Lying in special cavities of the meshwork are seen a gastrozooid and two dactylozooids in the retracted condition, together with two sets of male gonophores and three nematophores. The calcareous style of the gastrozooid is introduced in order to show the position which it occupies in the retracted condition of the zooid.

G Z. External opening of the sac of a retracted gastrozooid.

O. Mouth of the gastrozooid.

S. Gastric cavity lined in its upper part by large elongate ovoid gastric cells; in its lower, by ordinary endoderm cells.

T. One of the tentacles of the zooid, of which a pair are seen in section.

M. Longitudinal muscular layer of the zooid. The muscles are continued down on to the four main cœnosarcal canals leading from the base of the zooid.

E. Ectoderm layer of the zooid.

C. Cavity of one of the four large canals into which the zooid cavity divides at its base in order to become continuous with the canal system of the cœnosarc. This canal is here shown as cut open, and is seen to be lined with endoderm cells, the layer of which is continuous with that lining the zooid cavity.

S′. The calcareous style, here introduced to show the position which it occupies within the cavity of the zooid in the retracted condition of the latter. It is covered by a layer of ectoderm, and the endoderm lining layer of the zooid cavity is reflected over it.

F, F. Walls of the sacs of the zooids.

D Z, D Z. External openings of the sacs of two retracted dactylozooids, one of which is very small, the other of the largest size occurring.

B. Body cavity of the larger dactylozooid. In this zooid the ectoderm, E, is thrown into a series of folds in the retracted condition of the zooid. It presents on its outer surface a continuous layer of nematocysts. The zooid cavity is lined by a thick layer of endoderm. The zooid is attached to the side of the base of its containing sac, and is thus bent upon itself somewhat at its lower region.

R. Retractor muscles, continuations on to the main basal canal of the zooid of the longitudinal muscular layer, which is seen in section in the upper portion of the zooid.

N, N. Nematophores.

D. Surface layer of the ectoderm.

G, G′. Male gonophores. Those on the right seen in complete section, that on the left with its sac only open, the generative masses being left intact. In G a ripe male sac filled with mature spermatozoa is seen situate nearest the surface of the coral, and beneath is an immature gonophore with its centrally placed spadix of endoderm. The axis of the two generative masses not lying in the same plane, the spadix is not seen in the upper riper sac, which is not divided by the section through the axis.

X, X. Spaces between the branches of the cœnosarcal network in the region immediately adjoining the sac of the zooid, where these branches have a peculiarly radiate arrangement, called here inter-radial spaces.

A, A. Slips of fine membrane attached to the radial offsets.

## PLATE IV.

Section vertical to the surface of a portion of a decalcified female stock of *Errina labiata*, showing the form and dispositions of the zooids and gonophores. The meshes of the cœnosarcal network are, as in *Sporadopora*, closer and smaller in the more superficial than in the deeper regions of the coral. The zooids are all inclined towards the tip of the branch of the coral.

D Z, D Z, D Z. Dactylozooids. In two of these the sac or lining membrane of the pore is shown as cut open, in order to exhibit its relations to the contained and partly retracted zooid.

D. A dactylozooid in process of development as a bud.

G Z. Mouth of the sac of a gastrozooid, which sac is cut open in order to show the contained zooid.

T. Tentacle of the zooid. O. Its mouth.

C. Gastric Cavity. St. Style.

X, X. Spaces in the cœnosarcal network, homologous with the inter-radial spaces in *Sporadopora*.

Three gonophores are represented in the figures, showing three successive stages of development, the central one of the three being most advanced.

O V. Ovum. S. Spadix shown in section.

In the central gonophore the planula which is shown in section is doubled up somewhat, being fully developed, and ready to escape.

E C. Ectoderm of the planula.

E. Endoderm.

B. Membrane immediately covering the planula where not in contact with the spadix.

A. Surface layer of endoderm reflected over the wall of the ampulla.

In the remaining gonophore the developing planula and its spadix are shown entire, the surface membrane only covering the wall of the ampulla being seen in section.

P. Planula.

S′. Spadix showing the manner in which it forms a network and becomes digitate or fringed towards its outer margin.

N, N, N. Nematophores.

## PLATE V.

Longitudinal section through the axis of a branch of a stock of *Spinipora echinata*, decalcified, showing the cœnosarcal network and the surface membrane, with the various zooids in their mutual relations.

D Z, D Z, D Z. Indicate some of the larger dactylozooids, of which many are shown. These larger dactylozooids are situate near the extremities of spine-like processes of the cœnosteum, represented here by the corresponding laminæ of soft tissue, extensions of the surface layer of ectoderm. The processes are grooved on the side lying towards the tips of the coral branches, for the reception of the zooids, which are all shown here as much contracted.

A, A. Examples of the fusing of two adjacent processes.

B, B. Processes represented as cut open in order to show the disposition of the bases of the dactylozooids within, and their connection with the cœnosarcal network.

D, D. Small dactylozooids protruded from simple pores near the bases of the spine-like processes.

G Z, G Z, G Z. Gastrozooids seen ; some retracted within their sacs, others partially expanded. They have each a well-developed hypostome and six tentacles, and join the cœnosarcal network at their lower extremities by means of four main canals.

## PLATE VI.

Vertical section through one of the cyclo-systems of zooids of a male stock of *Allopora profunda* decalcified. Right and left of the centrally placed system, seen in section, are represented parts of two other similar systems, which are shown as seen from their outer aspects by transmitted light, and not in section.

D Z, D Z. Dactylozooids retracted. Arranged in a circlet around the mouth of the pore of the gastrozooid.

P, P. Sacs, or soft tissue walls of the pores, of dactylozooids, separated from one another by pseudosepta. Two of these sacs are shown cut open to display the attachment of the bases of the zooids within them.

G Z. Sac of the gastrozooid, between which and the place occupied in the recent condition by the wall of the pore of the zooid is a wide space, traversed by radially disposed offsets of the cœnosarcal network, R R.

X, X. Inter-radial spaces between these effects.

Z. Gastrozooid with twelve tentacles, disposed in a single whorl, and an almost hemispherical hypostome. Large canals spring from the base of the zooid, and form communications with the basal canals of adjacent zooid cyclo-systems.

D Z′, D Z′. Dactylozooids in their sheaths seen from behind within the adjacent zooid cyclo-systems.

G, G, G. Gonophores. The sac of one of these is cut open to show the ovoid male generative masses and their spadices lying within.

## PLATE VII.

Shows the structure of *Stylaster densicaulis* as seen in the decalcified condition. The cylindrical masses formed by three cyclo-systems of zooids are shown cut open, so as to demonstrate the arrangements of the zooids and cœnosarcal ramifications within them. The positions of the two additional cylco-systems are indicated by outline. In the centrally placed cyclo-system the entire ramifications of the cœnosarcal canals are shown.

In the system displayed on the left side of the figure, the wall of the sac of the gastrozooid, and the superficial network beneath it, are removed, in order to show the connections of the bases of the dactylozooids with the deeper canals.

In the system shown on the right in the figure, the details of the connection of the base of the gastrozooid with the cœnosarcal canals only are given.

The gonophores are seen through the superficial networks existing in the walls of the ampulla.

Z, Z. Gastrozooids situate one at the base of each cyclo-system.

D Z, D Z. Dactylozooids. G G. Male gonophores.

N, N. Nematophores.

A. Reflection of the surface layer of the ectoderm forming the sac of the gastrozooid and lining the gastropore. The sac-wall is very thin and transparent. Curved lines crossing the dactylozooids transversely about their middles, in the central cyclo-system shown in the figure, mark the lower and innermost margins of the dactylozooid sacs, where these become continuous with the sac of the gastrozooid. In the cyclo-system shown on the left in the figure, the sac of the gastrozooid and the portions of the sacs of the dactylozooids fronting the gastropore are represented as removed, together with the superficial network of the cœnosarc immediately beneath them, in order to display the connections of the deeper systems of large main canals which connects the zooids of the cyclo-system directly with one another.

B, B. Spaces in this deeper system of main canals.

## PLATE VIII.

Fig. 1. Shows the structure of the soft parts of *Astylus subviridis*. A single cyclo-system, divided in half, together with portions of the branch on which it rests, is represented in the figure. At the lower part of the figure the large cœnosarcal canals occupying the axis of the branch are seen passing right and left. These place the cyclo-system in connection with the other adjacent cyclo-systems on the branches of the coral. The gastrozooid, which is devoid of tentacles, is seen resting retracted at the bottom of its sac (A). The base of the gastrozooid is rounded and basin-shaped. Large canals spring from the margin of the basin to join the cœnosarcal meshwork, and carry into the general circulation the products of digestion, but none such arise from the direct under surface of the zooid.

G Z. Cavity of the upper chamber of the sac of the gastrozooid.

G Z. Cavity of the lower chamber of the sac of the gastrozooid.

Z. The gastrozooid.

O. The mouth appearing as a crucial slit with symmetrically arranged elongate gastric cells.

B. Tongue-like process of the wall of the gastropore which projects forwards horizontally over the summit of the retracted gastrozooid at a point where there is a sudden constriction of the pore. The projection of the tongue forms the opening of the constriction into a horseshoe-shaped aperture.

D Z, D Z. Dactylozooids retracted into their pores, and doubled down into the mouth of the sac of the gastrozooid.

P, P. Mouths of the sacs of the dactylozooids, occupying in the recent condition the dactylopores. These mouths are in this species elongate in outline, and simulate the interseptal spaces of Anthozoan corals.

G, G. Male gonophores in special sacs, and springing from branches of the cœnosarcal network.

C. Deep axial cœnosarcal canals of the branches of the coral on which the cyclo-systems rest.

S, S. Superficial networks of finer canals lying immediately beneath the superficial external layer of the ectoderm.

R, R. Radially disposed offsets of the cœnosarcal network springing from the sac of the gastrozooid.

X, X. Inter-radial spaces (*cf.* Pl. VI. R R, X X).

Fig. 2. Shows the structure of the soft parts of a female stock of *Pliobothrus symmetricus*. The structure is exposed by means of a section vertical to the surface of the coral. The mass of the coral, the hard skeleton being removed, is composed of the usual cœnosarcal meshwork which is bounded externally by a continuous surface layer of ectoderm containing large nematocysts. Embedded in the meshwork are two kinds of zooids and the gonophores. The sac or sheath of the single gastrozooid shown in the figure is opened in order to display the zooid within.

Z. Gastrozooid. S placed in the neck of the sac of the gastrozooid.

X, X. Spaces in the meshwork corresponding to the inter-radial spaces in *Sporadopora*. Here the radial arrangement is hardly to be discerned.

D Z, D Z, Dactylozooids. The transverse lines drawn encircling the bodies of these zooids indicate folds into which the bodies of the zooids are thrown in extreme retraction.

O. Rests on a cup-shaped spadix, bearing a mature unimpregnated ovum, containing a germinal vesicle.

G. Impregnated ovum in an early stage of development.

P. Planula nearly mature contained within its sac.

Fig. 3. Male gonophore of *Pliobothrus symmetricus*.

## PLATE IX.

Shows the structure of the soft parts of *Cryptohelia pudica* displayed by decalcification.

The figure represents two cyclo-systems of zooids, together with the short branch of the coral connecting them. The cyclo-system on the left hand in the figure is represented as laid open by a vertical cut passing through the axis of the gastrozooid, and the disposition of the several parts is here shown in detail. The breeding sac of this system is in an early stage of development. The dactylozooids are shown as protruded.

In the cyclo-system on the right hand the superficial membrane is mostly left entire, and the cyclo-system is not opened, but a view is obtained into the open mouth of the gastropore showing the dactylozooids doubled down into it. The breeding sac is here shown in its fullest activity, and containing a planula ready for emergence. The sac is represented as cut open in order to exhibit the contained structures.

G Z. Cavity of the sac of the gastrozooid.

O. Mouth of the gastrozooid, which is devoid of tentacles.

S. Digestive cavity of the zooid lined with elongate gastric cells.

M. Longitudinal muscular layer of the zooid. As in *Astylus subviridis*, numerous canals pass off from the margin of the rounded base of the zooid, but none from the under surface of base itself.

D Z, D Z. Dactylozooids.

P. P. Mouths of the sacs of the dactylozooids.

L, L. Peculiar protective laminæ, or lids, folded in this genus in front of the openings of the cyclo-systems. In the case of the left-hand system of the figure the ramifications of the superficial network of the cœnosarc, prolonged into the body of the lid, are shown, and also the nematophores with which the lid is provided. In the other system represented, the superficial layer of the cœnosarc is shown intact. The downward prolongation of the base of the lid which should pass between the sac of the gastrozooid and its main upward canals, is omitted for clearness' sake.

N, N. Nematophores. One of these is situate at the outer margin of the cyclo-system in each interval between the sacs of the dactylozooids.

G. Female gonophore contained, with two others in earlier stages, in a special brood-sac as yet not far advanced in development.

G′. Brood-sac in full development containing ova and embryos in all stages of development.

Ov, Ov′. Fertilised ova in advancing stages of development and cell multiplication.

P 1. Early stages of planula embryo. The thin ectoderm appears as just differentiated.

P 2. Planula fully advanced with more fully developed and thickened ectoderm.

P 3. Fully developed planula with highly differentiated ectoderm containing nematocysts, &c.

## PLATE X.

Shows certain details of structure of the soft parts of *Sporadopora dichotoma* and of *Astylus subviridis*.

Fig. 1. Section transverse to the longitudinal axis of a gastrozooid of *Sporadopora dichotoma*, taken at a point above the junction of the tentacles with the body of the zooid. Hence the tentacles appear in this section as isolated structures.

S. Digestive cavity.

G. Large gastric cells with their nuclei.

M. Muscular layer and basement membrane at this region of the zooid comparatively little developed. Shows longitudinal fibres cut across.

E. Ectoderm here containing very few nematocysts but numerous nuclei.

T, T. Tentacles in section.

Fig. 2. Section transverse to the longitudinal axis of a large dactylozooid of *Sporadopora dichotoma.*

B. Body cavity of the zooid.

L. Endoderm consisting of a double layer of large transparent nucleated cells with smaller cells on its inner aspect.

M. Muscular layer and basement membrane showing a series of stout isolated fibres.

E. Ectoderm. This forms a thick layer which contains numerous nuclei and developing nematocysts, and at its outer surface is protected by a continuous layer, one cell deep, of nematocysts of the smaller form.

Fig. 3. Section parallel to the surface of the soft tissues of *Sporadopora dichotoma* taken at a very slight depth just beneath the superficial layer of the ectoderm. The soft structures about the mouths of the sacs of a gastrozooid and a contiguous dactylozooid are shown, and the radiate arrangement of the cœnosarcal tubes around the sac openings.

G Z. Lumen of the upper part of the sac of a gastrozooid.

R M. Wall of the sac containing radially disposed fusiform muscular elements which are prolonged outwards on to the radial offsets of the cœnosarc. The wall of the sac is lined internally by small rounded cells.

R, R. Radially disposed offsets of the cœnosarcal meshwork which pass inwards to join the outer surface of the sac all round.

A, A. Slips of fine transparent membrane containing nuclei attached to the radial offsets.

X, X. Inter-radial spaces.

D Z. Lumen of the sac of a dactylozooid with somewhat similar arrangement to that in the case of the gastrozooid.

N, N. Nematophores. Closely packed batteries of the larger form of nematocysts, which are here seen in transverse section.

Fig. 4. Tentacle of a gastrozooid of *Sporadopora dichotoma*, from a sketch made of the animal in the fresh condition.

K. Elongate knob-like tip of the tentacle thickly beset with nematocysts of the smaller form.

E. Ectoderm.

Tr. "Apparent septa."

C. Axial cavity of the tentacle.

Fig. 5. Section transverse to the axis of the zooid of a segment of the body wall of a gastrozooid of *Sporadopora dichotoma*, taken near the lower region of the zooid.

S. Wall of the sac of the zooid seen in section.

E. Ectoderm.

M. Muscular and basement layer showing a series of stout longitudinal slips in section.

L. Layer of transparent endodermal cells, the representatives in this region of the larger elongate gastric cells which exists higher up in the body cavity.

EN. Pigmented endoderm cells, such as line the canals of the cœnosarcal meshwork.

Fig. 6. Portion of the muscular layer of the body wall of a gastrozooid of *Sporadopora dichotoma* viewed from its inner surface. The layer is seen to be composed of a closely set series of longitudinal narrow muscular slips. The layer is crossed by fine transverse striations, the nature of which was not determined, no definite circular muscular fibres having been detected in the zooids. The striations probably are caused by wrinkles in the basement membrane.

Fig. 7. One of the longitudinal muscular slips of the last figure, much enlarged, to show that it is composed of fusiform nucleate closely-packed elements.[1]

Fig. 8. These fusiform muscular elements still more magnified.

Fig. 9. Nematocysts of *Sporadopora dichotoma*.

*a* Elongate form of nematocysts occurring only in the nematophores and surface layer of the ectoderm, and that investing the more superficial cœnosarcal canals. *a'* The same, with the thread protruded.

*b* Smaller form of nematocyst, abundant in the tentacles of the gastrozooids, ectoderm of the dactylozooids, and other regions. *b'* The same, with the thread protruded.

*c*, *d*, *e* Successive stages in the development of the smaller form of nematocyst.

Fig. 10. Section through a portion of a male gonophore sac of *Astylus subviridis*, showing various stages in the development of spermatozoa (*cf.* Pl. VIII. G).

S. Wall of the gonophore sac, a reflection of the ectoderm.

S'. Reflection of the same over one of the lobules of the generative mass.

S''. Thin membrane enclosing the spermatozoa within the lobule.

[1] N.B.—By error in plate marked × 100 instead of × 600.

E N. Endoderm cells. These apparently continuous with those forming the lining of the canals of the cœnosarcal meshwork, X X, expand into a centrally-placed mass from which the lobules spring. The lobules as they approach maturity become attached by narrow pedicles.

*a* One of the earliest stages in the development of a lobule.

*b* More advanced stage showing a multiplication of the contained cells.

*c* Further stage with more numerous and smaller spermatogenous cells.

*d* Further stage. The character of the contained cells is changed.

*e* More advanced stage.

*f*, *g*, *h* Further stages. *h*, *h* Containing mature spermatozoa.

Fig. 11. Successive stages in the development of the spermatozoa of *Astylus subviridis.*

*a* Ordinary endoderm cell.

*d* The opaque constituents of the cell are entirely condensed into the nucleus.

*e* Smaller similar cell produced by division of the above.

*e'*, *f*, *g* Successive stages showing the development of the spermatozoon from the nucleus.

Fig. 12. Ripe spermatozoa of *Sporadopora dichotoma* as seen in the living condition. A vesicle is present situate between the head and commencement of the filament of the spermatozoon. In the case of the lower spermatozoon of the three figured, the head, which is flattened, is viewed edge on.

## PLATE XI.

Fig. 1. Gastrozooid of *Cryptohelia pudica,* removed from its sac, and viewed directly from above so as to be much foreshortened in the drawing.

A. The cruciform mouth, with a lining of elongate gastric cells.

B. Main canals given off from the outer margin of the base of the zooid all round. These soon branch, and join by their offsets the general cœnosarcal meshwork.

The zooid is seen to be devoid of tentacles.

Fig. 2. Part of a section, cut at right angles to the axis, of a cyclo-system of *Astylus subviridis,* showing the structures surrounding the pores of the dactylozooids at the margin of the system.

D. Transverse section of a dactylozooid, showing ectoderm, endoderm, and intermediate muscular layer.

P. Cavity of the sac of the zooid, occupying, in the recent condition, the wide upper chamber of the dactylopore.

D′. Another dactylozooid, seen in section. The zooid, being doubled back into the outer part of the dactylopore where cut in section, its cavity appears partly as a lumen at T′, partly as an elongate hollowed area, in which are seen the strong longitudinal retractor muscles of the zooid.

C, C. Tortuous canals, offsets of the general cœnosarcal meshwork, which pass radially outwards in the substance of the pseudosepta, between the pores of the dactylozooids. The canals ramify as they reach the outer margin of the calicular system, and join by their branches the superficial outer network of the cœnosarc.

N. Large ovoid nematophore, full of closely-packed nematocysts. One such nematophore is present in each interval between the outer margins of the mouths of the pores of the dactylozooids.

Fig. 3. Earliest stage in the development of the ovum in *Cryptohelia pudica*.

A bud-like mass of endoderm cells is gathered together within an offset of a branch of the cœnosarcal meshwork.

Fig. 4. The same, in a further stage of development.

O. Ovum, with germinal vesicle and spot.

S. Spadix, composed of endoderm cells.

E. Thin layer of the ectoderm, continuous with that covering the spadix, and investing the free surface of the ovum.

Fig. 5. Section through a planula of *Cryptohelia pudica*, in a very early stage.

E. Ectoderm.

En. Endoderm.

Fig. 6. Portion of a planula of *Cryptohelia pudica*, in a more advanced stage than the foregoing, viewed from the outer surface.

E. Ectoderm, transparent, and showing a demarcation into the polygonal areas.

En. Endoderm cells, seen through the transparent ectoderm.

Fig. 7. Section vertical to the surface of a planula of *Cryptohelia pudica* when fully developed and ready for exit from the broad sac.

En. Endoderm, composed mainly of oily globules.

E. Ectoderm, which is extremely thick, and for the most part transparent and gelatinous in appearance.

N, N. Nematocysts.

A. Tracts composed of small, rounded, non-transparent ectodermal elements, which run from the endoderm region at intervals ver-

tically towards the surface of the planula. In these tracts the nematocysts are developed.

B. A layer of the same elements lying next to the outer surface of the endoderm.

Fig. 8. A portion of the same planula, viewed from the surface, to show the manner in which the surface is marked out into polygonal areas, by the special arrangement within the substance of the ectoderm of the nematocysts and tracts in which they are developed.

N, N. Nematocysts, seen in optical section.

A, A. Elements amongst which they are developed.

Fig. 9. Section, vertical to the surface, of a nearly mature planula of *Errina labiata*.

E. Ectoderm, composed of alternate transparent and more opaque tracts, disposed vertically to the surface.

A. The more opaque tracts, containing numerous nuclei and young thread cells.

B. Basement membrane.

En. Endoderm, composed of fatty bodies and granules, and containing—

N, N. Developing nematocysts.

O. Large oil-globules.

Fig. 10. Portion of the surface layer of the ectoderm of *Errina labiata*, viewed from the outer surface.

S, S. Polygonal nucleated cells composing the layer. These in places overlap.

N, N. Nematocysts seen *in situ* within these transparent superficial cells.

Fig. 11. Section, vertical to the surface, of the ectoderm of a gastrozooid of *Errina labiata*.

E. Superficial layer, composed of inflated transparent nucleated cells.

E′. Inferior layer of the ectoderm containing numerous nuclei.

Fig. 12. Section, transverse to the axis, of a cyclo-system of *Allopora profunda*, taken at some little distance below the level of the mouths of the pores of the zooids, showing the sac only of the retracted gastrozooid in section, but both sacs and zooids of the dactylozooids. The whole is represented as decalcified, with the exception of the styles of the dactylozooids, which are introduced to show the position which they occupy in the recent state of the coral (*cf.* Pl. VI.).

R, R. Radially disposed offsets of the cœnosarc.

G Z. Cavity of the sac of the gastrozooid.

X, X. Inter-radial spaces between these.

D Z. Dactylozooid, showing in section its three composing layers, ectoderm, endoderm, and intermediate muscular and membranous layer.

C. Style of one of the dactylozooids, seen in section.

B. Large canals of the cœnosarc, occurring in the pseudosepta or intervals between the dactylopores.

S. Surface layer of the ectoderm. The main mass of tissue is composed of the finer ramifications of the cœnosarcal meshwork.

Fig. 13. Small portion of the cœnosarcal meshwork of *Sporadopora dichotoma*, greatly magnified in order to show the histological structure; as seen in osmic acid preparations.

C. Channel of the canal.

En, En. Endoderm layer.

M M. Membranous layer.

E E. Ectoderm.

T. Nematocysts in process of development.

Fig. 14. Two pigmented cells of the endoderm of the same, highly magnified.

## PLATE XII.

Shows the structure of the cœnostea of several species of Stylasteridæ.

Figs. 1–4. *Stenohelia profunda.* Off St Thomas, Danish West Indies. 450 fathoms.

Figs. 1, 2. Specimens drawn of the natural size to show the mode of branching.

Fig. 3. A specimen enlarged to show the arrangement of the cyclo-systems. *a* Two cyclo-systems of the same, to show the mode in which the young terminal cyclo-systems bud out from the adult axial systems, and the arrangement of the ampullæ around one of the latter.

Fig. 4. Diagrammatic longitudinal section through two calicles such as shown in the foregoing figure. At the base of the tube of the young cyclo-system is seen the minute style. The ampullæ are laid open.

Figs. 5, 6. *Conopora tenuis.* Off the Kermadec Islands. 650 fathoms.

Fig. 5. A specimen drawn of the natural size. *a* The same enlarged. The stem is deformed, being enlarged, and hollowed out by a cavity occupied in the recent state by a parasitic Annelid. *b* Mouth of one of the cyclo-systems much enlarged.

Fig. 6. Diagrammatic longitudinal section through one of the cyclo-systems to show its two chambers, the form of the gastropore and its connections with the dactylopores.

Fig. 7. *Cryptohelia pudica.* Lat. 25° 45′ N., long. 20° 12′ W. 1525 fathoms.

Fig. 7. A large finely-grown specimen, but with one principal branch broken off. *a* Side view of one of the cyclo-systems and its attached branches, to show the form of its margin and of its lid. *b* Two cyclo-systems of the same viewed from above, to show the form and extent of the lids.

Fig. 8. *Distichopora irregularis.* Off Samboangan, Philippine Islands. 10 fathoms.

Fig. 8. A specimen of twice the natural size to show the distribution of the lines of pores. *a* Tip of a branch of the same, much magnified to show the arrangement of the gastropores and dactylopores.

## PLATE XIII.

All the figures except fig. 7 represent structures occurring in *Millepora nodosa.*

Fig. 1. Ovoid nematocyst, confined in position to the bases of the zooids and general superficial layer, not occurring in the tentacles. *a* The cell expanded. *b* The cell with the thread fully projected. The respective lengths of the various parts of the thread and cell are drawn exactly according to measurements.

Fig. 2. Three-barbed nematocyst, of the form peculiar to Hydrozoa, occurring in the tentacles of the zooids and also sparingly on the general surface of the coral. *a* The cell with its head protruded and thread partially projected. *b* The cell in the unexpanded condition. The figures are drawn exactly to measurements.

Fig. 3. View of a portion of the cœnosteum, magnified 2 diameters.

Fig. 4. View of the surface of the cœnosteum, magnified 80 diameters, showing one complete system of pores, composed of a central gastropore, and eight surrounding smaller dactylopores.

Diameter of the central gastropore = 0·25 mm.

Largest diameter of the whole group of pores = 1·5 mm.

Drawn by Dr J. J. Wild, Artist to the Challenger Expedition.

Fig. 5. Enlarged view of a vertical section of the cœnosteum.

C. Zooid-cavity or pore.

B, B. Branches of the canal-system.

Fig. 6. Section of the cœnosteum cut parallel to its outer surface, showing a portion of a system of zooids.

C. Gastropore in horizontal section.

C′, C′. Dactylopores.

B′. Branch of a canal-system which communicates by means of a lateral offset with one of the dactylopore cavities.

The dark linear bodies represented as embedded in the calcareous matter are cavities bored by parasitic vegetable organisms, the black dots being spore-cavities. In one of the dactylopores a branched mycelial thread is seen to cross over between the tubular cavities bored in the cœnosteum.

Fig. 7. Shows the appearance presented under transmitted light by a thin horizontal section of the cœnosteum of a species of *Millepora* from Samboangan, Philippines, in which the pores and canal-systems have become filled with opaque matter. The black streaks thus shown represent the ramifications of the canals of the cœnosarc within the tortuous canals in the substance of the cœnosteum, and show their anastomoses with the pore cavities.

Fig. 8. Portion of a fine section of the cœnosteum, as seen under Hartnach's objective No. 8, eyepiece No. 3.

The canals bored by the parasitic fungus are seen traversing the calcareous matter.

At ($\alpha$) the fibro-crystalline elements of the hard tissue project in a series of points.

## PLATE XIV.

Various structures occurring in *Millepora nodosa*.

Fig. 1. View of a group of zooids in the expanded condition. In the centre is the short gastrozooid, provided with only four tentacles. Grouped around are seen five dactylozooids. A sixth dactylozooid belonging to the group is omitted from the drawing for the sake of clearness.

Fig. 2. Vertical section of the decalcified living superficial lamina. A gastrozooid and a dactylozooid are shown in the retracted condition. In the gastrozooid one tentacle is omitted for the sake of clearness. The open spaces in the network of the cœnosarc are in the recent condition occupied by the calcareous network. The vessels are in places cut through, and have the pigmented endodermal cells exposed to view.

E. Superficial layer of the ectoderm.

D Z. Dactylozooid.

G S. Gastrozooid.

A. One of the spaces occupied by calcareous matter in the recent condition.

B. Secondary branch of one of the canals of the cœnosarc.

O. One of the cut openings into one of the vessels.

Fig. 3. View of a group of zooids as seen in the contracted condition. One gastrozooid and three of the surrounding dactylozooids are shown. The gastrozooid here has five tentacles. The surface of the decalcified coral is here represented as seen when viewed from above, with the microscope focused somewhat into the depths of the structure. A deep focus is necessary in order to reach the far-retracted zooids. The deeper reticulations of the cœnosarc are thus brought into view.

M Z. Gastrozooid.

Z, Z. Dactylozooids.

Fig. 4. View of the inferior surface of the superficial living lamina, from a specimen decalcified in chromic acid and viewed by reflected light. The figure shows the ramifications of the canals and vessels of the cœnosarc and their connections with the zooids of one complete group or system.

G Z. Under surface of gastrozooid.

D Z. One of the seven surrounding dactylozooids.

C. Canal.

B, B. Branches of this canal.

B′, B′. Secondary branches, from which and from B B arises a complicated network of finer vessels.

Fig. 5. Enlarged view of a tentacle of a dactylozooid.

K. Spherical head of the tentacle filled with thread-cells of various sizes.

E. Ectodermal layer.

R C. Ramified cells or nuclei of the endodermal layer.

M. Membranous layer.

P. Pigmented cells within the cavity of the tentacle.

C. Body cavity continuous with that of the tentacle.

Fig. 6. Diagram showing the arrangement of the muscular fibres in a gastrozooid. The longitudinal muscles are gathered into bundles, which pass outwards for insertion on to the radially disposed vessels of the cœnosarc. Other fibres, less densely placed, occupy the interspaces between these bundles.

O. Mouth of the gastrozooid

A, A. Radially disposed vascular offsets from the base of the gastrozooid.

L M. Longitudinal muscular bundles.

C M. Circular muscular fibres.

Fig. 7. Transverse section of a gastrozooid.

E. Ectodermal layer, containing thread-cells in various stages of development.

M. Membranous layer.

L M. Longitudinal muscular fibres seen in section as a series of dark points.

G. Gastric cells.

The narrow dark zone between the longitudinal muscles and the membranous layer indicates possibly a circular muscular layer.

Fig. 8. Small portion of a vertical section of the cœnosarc, much enlarged, showing the histological structure of the vascular network. The vessels are seen cut open in almost their entire course. The walls of the deeper vessels are very thin, and these vessels are filled with transparent spherical globules. More superficially the walls of the vessels become thickened, and the cells composing their ectodermal layer are seen in several places to be in process of development into thread-cells. At the actual surface the cells of the ectoderm assume an elongate prismatic form. The vessels of the more superficial parts of the network are filled with the pigmented cells, mingled with transparent globules.

E. Superficial layer of the ectoderm.

M. Membranous layer of the cœnosarcal canal.

C, C. Pigmented cells lying in the cavities of the canal.

B. Transparent globules filling the deeper ramifications.

T, T. Developing ovoid thread-cells.

T′. Developing thread-cells of the form peculiar to Hydrozoa.

S. Band of gelatinous tissue passing between the walls of two neighbouring vessels.

A, A. Spaces occupied in the recent condition by calcareous matter.

A′. Such a space in the superficial ectodermal layer.

O. Opening in a vessel cut at right angles to its course.

Fig. 9. Pigmented cells, of which the endoderm of the cœnosarcal vessels is mainly composed, and which are abundant also within the body-cavities of the zooids. *a*, *d*, *d* Examples of the cells, showing various forms and arrangements of the pigmented granules and vesicles which compose their contents. *c* Cell showing a division of its contents into two. *b* Cell showing a further division of its contents into four.

# HELIOPORIDÆ—I., II.

*Note.*—Both plates illustrate the structure of *Heliopora cærulea* and *Sarcophyton* sp. All the drawings, with the exception of figs. 10 and 11, Plate II., are by the author. Figs. 10 and 11, Plate II., are by Dr J. J. Wild.

## PLATE I.

Fig. 1. Schematic representation of a section vertical to the surface of *Heliopora cærulea*, showing the relations of the hard to the soft parts: the hard parts are coloured dark. In the centre is seen in section a fully-developed sexually mature polyp in a retracted condition. The calcareous calicle in which it is contained is closed beneath by the tabula (CT), and the walls of the calicle are continued above into points (P) projecting above the general surface of the coral, the section being supposed to be so carried as to pass through two of the calcareous projections which surround the calicle.

Closely applied to the surfaces of the calcareous tissue, and lining its cavities everywhere, is a layer of spindle-shaped connective tissue cells, between which and the layer of endodermal cells is an interval occupied by transparent homogeneous connective tissue.

The external layer of ectoderm (E) covering the whole surface of the coral is seen to be continuous with that covering the exterior of the tentacles (here, from the introversion of those organs, appearing as their interior), whilst the endodermal layer (EN) covers their interior. The tentacle on the right side of the drawing is represented as having its tip cut off so as to display the full extent of the retractor muscle, and in order to show the position of the ovum (O). At the bottom of the atrium, *i.e.*, the central canal leading from the mouth and tentacles to the exterior, and formed by the deep retraction of the animal, are shown the mouths of the tubes formed by the introversion of two tentacles as they appear when looked directly into. Their lumen is cruciform.

On the right hand side of the figure three tubular cavities (TC, TC, TC), forming the so-called cœnenchym, are represented, lined by their soft tissues, composed of the same three layers which compose the lining of the calicle. Two of the tubes communicate above, over their lateral wall, by one of the

deep canals. On the left-hand side of the figure portions of the plates of hard tissue forming the lateral walls of the tubular cavities are shown (A, A), with their natural upper margin. Two systems of canals are seen in section near the surface of the coral. The most superficial canals (V, V, V) lie almost immediately beneath the external ectodermal layer; they are more numerous and much smaller than the deeper canals (V′, V′), which form communications between the adjacent tubular cavities passing over the summits of the lower parts of their walls as is seen on the right-hand side of the figure. Both sets of canals are lined with endodermal cells.

A A. Portions of the walls of the tubular cavities.
C T. Calcareous tabulæ.
P. Projecting points of calcareous tissue.
E. External layer of ectoderm.
E N. Endoderm.
C. Mesodermal layer of homogeneous connective tissue.
D. Layer of connective tissue cells.
T. Tentacles introverted, seen in longitudinal section.
T'. Tentacles introverted, viewed directly into their mouths.
S. Cavity of stomach.
R M. Retractor muscle.
M F. Mesenterial filament.
T C. Tubular cavities of cœnenchym.
V. Superficial smaller vascular canals.
V′. Deep larger vascular canals.

Fig. 2. Section vertical to the upper surface of *Sarcophyton* sp., showing three autozooids and a number of siphonozooids.

The autozooids are represented in the contracted condition; they occupy three large elongate cavities in the general transparent sarcosome. The tentacles here are not introverted but simply retracted. The sarcosome between the autozooid cavities is traversed by an elaborate network of canals belonging to two systems, a transverse one, and a vertical one, which, however, freely anastomose. The tranverse canals lead directly from one autozooid cavity to another, with a course nearly parallel to the surface plane of the *Sarcophyton*, or from the autozooid cavities to the siphonozooid cavities. The vertical system of canals has a tortuous, branching, freely anastomosing course. The siphonozooid cavities contract at their lower extremities, and pass directly into this system of canals. Prolongations of the vertical system of canals pass up to the surface between the siphonozooid cavities, and between these and the autozooid cavities.

Z. Autozooids.

P M. Protractor muscle.

R M. Retractor muscle.

C. One of the canals of the transverse system.

Fig. 3. Diagrammatic representation of a transverse section across a polyp of *Heliopora cærulea* decalcified, taken just below the mouth. The tips of four of the tentacles cut across are retained *in situ;* the other four tips had fallen out in the section from which the drawing was constructed.

D. External layer of connective tissue cells.

C. Layer of homogeneous connective tissue giving off a series of stout offsets (A), which pierce the layer (D) and project externally. Continuations of this same layer are seen to form the central plate of the mesenteries and a wall around the stomach.

E N. Endoderm lining the whole of the intermesenteric chambers.

M. Mesenteries.

R M. Retractor muscles. The "Dorsalfach" of Kölliker lies below in the drawing, the "Ventralfach" above. The muscles are covered by the endoderm.

T T. Tentacles cut across.

S. Stomach. B. Its muscular layer.

Fig. 4. Section parallel to the surface of *Heliopora cærulea*, to show the relation of the hard parts to the soft.

T C, T C and the similar oval spaces represent the tubular cavities of the cœnenchym cut across. The interspaces between these cavities are occupied by the hard tissue.

The hard tissue is fibrous in structure, the fibres radiating from a series of axes here seen cut across (C). Suture-like lines (S) occur occasionally where the peripheries of the various radiating systems join.

D. Layer of connective tissue cells.

C. Layer of homogeneous connective tissue.

E N. Endodermal layer.

Fig. 5. Polyp of *Heliopora cærulea* and the immediately surrounding structures as viewed in a thick horizontal section from the outer surface.

The external ectodermal layer is not seen, being too transparent. The superficial projecting points of the hard tissue of the corallum being opaque, are shown shaded dark. Away from the calicle the points are arranged in parallel rows. All over the surface are seen the tops of the ramifications of the superficial system of canals or sinus (fig. 1, V, V); those immediately

around the polyp-lobes have a radiate arrangement. These canal cavities are lined with endodermal cells.

In the centre of the drawing are seen the eight lobes of the contracted polyp with the mouth of the atrium in their centre. In their peripheral region the endodermal lining of the cavities of these lobes is seen showing through their superficial tissue.

Each of the lobes further shows a fine longitudinal striation, probably caused by muscular fibres, and some very small nuclei at its inner aspect.

P. Projecting points of the corallum.

A A. Sinus of the superficial canal-system.

L. Lobes of contracted polyp.

Fig. 6. Portion of a section of *Heliopora cærulea* cut parallel to the surface and viewed from beneath. From a specimen decalcified in chromic acid. The drawing represents a spot where a growing point of the corallum has been removed by the acid.

E N. Endodermal layer.

C. Homogeneous connective tissue layer.

D. Layer of connective tissue cells.

B. Very finely fibrous mass from which the calcareous tissue has been removed.

A. Cavity in the mass.

## PLATE II.

Fig. 1. Diagram to show the canal-systems in connection with the summits of the cœnenchymal tubes and calicles.

A. Cavity of a calicle.

B. Cavity of a tube.

D. Walls of the tubes and calicles in longitudinal section.

The channels of the deep canal-system (V, V′) lead over the summits of the walls from one tube to another, and from the tubes to the calicular cavities. The canal (V′) opening into the calicular cavity in the figure corresponds to the opening (O) in fig. 2.

C. A similar canal leading into a tube behind B.

Above in the figure is seen the superficial canal-system, consisting of smaller canals and sinus communicating with the deep canals and roofs of the cœnenchymal tubes and also laterally with one another. These smaller canals having usually a vertical course. Their summits are seen in Plate I. fig. 5.

Fig. 2. Transverse section through the uppermost part of a retracted polyp of *Heliopora cærulea*, as viewed from below, showing the under surface of the most superficial structures closing the mouth of the calicle, *i.e.*, the immediate under surface of the polyp-lobes seen in Plate I. fig. 5, and Plate II. fig. 1. The drawing is from a decalcified preparation. The soft parts lining the wall of the calcareous calicle are cut through; they retain the form of the calicle, to which they were closely applied. The wall presents a series of longitudinal folds so as on transverse section to show a sinuous outline with twelve indentations separated by twelve bulgings. The indentations occupied in the fresh condition of the animal by calcareous matter represent the twelve ridge-like calcareous septa present in the calicle. The indentations are neither in form nor arrangement symmetrical, nor are the eight mesenteries (MM) arranged symmetrically with regard to them.

Between the mesenteries the body-wall of the polyp does not reach outwards everywhere the entire distance to the wall of the calicle, but is continuous with this only in the region of its indentations. At each of the bulgings of the wall a wide aperture is left, by which the cavity of the polyp communicates with the canal systems around.

M M. Mesenteries.

O O. Openings by which the polyp cavity communicates with the canal-systems. The light oval spaces shown in the shaded areas of the openings are the sinus of the superficial canal-system.

Fig. 3. Vertical section through one of the siphonozooids of *Sarcophyton*. On the left-hand side of the drawing the calcareous spicules are shown *in situ*. On the right the appearance presented after these have been removed by acid is shown.

The points of the spicules accompanied by a layer of connective tissue project up far into the prominent layer and raise it up just as do the external ectodermal points of hard tissue in *Heliopora*. The connective tissue shows excessively small ramified nuclei scattered through its otherwise homogeneous tissue. Portions of adjacent siphonozooid cavities are shown on either side of the central one; the transverse fibrillation of their wall is indicated.

Sp. Spicules.

S.C. Cavities from which spicules have been removed by acid.

S. Stomach of the siphonozooid provided within with cilia directed inwards.

M E. Its mesenteries.

M F. Mesenterial filaments.

C. Canal of the transverse system, forming a communication between two adjacent siphonozooid cavities and lined by endodermal cells continuous with the layers lining the siphonozooid cavities.

E N. Endoderm.

C. Canal cut transversely.

Fig. 4. Portion of the superficial structures of *Heliopora cærulea* as viewed in a thin vertical section.

E. Ectoderm, consisting of elongate club-shaped cells running out below into fine processes, which traverse the next succeeding layer (M) of homogeneous connective tissue. At the bases of these cells are others of similar structure but irregular form. Small nematocysts lie amongst these external ectodermal cells, and some of them (N) are shown in the deeper regions. At EN the wall of one of the tubular cavities of the cœnenchym is seen in section at its edge, showing its three layers and the residue of animal matter (P) left by parts of its calcareous wall after decalcification.

Between EN and the section of the wall of the canal (V′) a narrow strip of the inner surface of the tubular cavity is viewed from its surface aspect.

E. External ectodermal layer.

M. Layer of homogeneous connective tissue.

N. Nematocysts.

C. Connective tissue cells.

V. Canal of superficial system.

V′. Canal of deep system.

E N. Endodermal cells.

D. Layer of connective tissue cells.

P. Residue of tissue after decalcification of a portion of the wall of a cœnenchym tube.

Fig. 5. Section vertical to the surface of the corallum of *Heliopora cærulea*, showing the structure of the hard tissue.

A. Former calicular cavity shut off from the recent calicle A′ by the tabula, C.

The tube cavities on either side have similar tabulæ developed in them. In the cases of some of the tubes the tube walls are shown as cut parallel to their surfaces, in other places the cut edges of the walls only are seen.

The tabulæ being applied against the already formed insides of the calicles and tubes as a later formation, the line of the old wall of the calicle in each case can always be traced up for some distance past the level of the tubula, which appears as the bottom of a second tube fitted within the first. The calcareous fibres forming the walls of the tubes and calicles are inclined upwards and outwards at a uniform angle from the vertical axes of these structures.

A. Former; A′, recent calicular cavity.

C, C. Tabulæ.

B. Portion of wall of tube cut parallel to its surface, in which a line of suture between the fibres of opposite systems composing it is to be observed.

D. Vertical canal.

P. Point of growing coral showing lines of successive growth.

The numbers 1, 1′; 2, 2″, &c., indicate the order in which the successive chambers were formed.

Fig. 6. Portion of the hard tissue forming the wall of a tube cavity of *Heliopora cærulea*, from the same preparation as fig. 5, more highly magnified.

C. Axis.

B. Shaded band caused by the fact that part of the calcareous tissue is stained of a more intense blue than the remainder. A similar band is seen on the opposite side of the axis.

Fig. 7. *a*, *a* Two of the cells of the endoderm of *Heliopora cærulea*; one of these with the contents undergoing fission.

*b′* Nematocyst of the same. *b* A form of nematocyst commonly to be observed in which the thread is partly protruded and curved in a loop, whilst one side of the cell is bulged in.

Fig. 8. Ovum of *Heliopora cærulea* as attached to the mesentery.

Fig. 9. Diagram to show the growth of *Heliopora* by a process of successive buddings and developments of tabulæ.

A. The original calicle of the stock: A′, A″, &c., successively formed chambers in continuation of this calicle; 1, 2, 3, successive lateral buds.

B. Formation of a new calicle. A short tube buds out, but the tubes on either side of it grow more quickly. Only the outer part of their walls continues to be developed; hence a wide circular cavity is formed with the original short tube at its bottom.

Fig. 10. Drawing by Dr J. J. Wild, Artist to the Challenger Expedition, of the rapidly growing tip of a frond of *Heliopora cærulea*.

The young growing tubes of the cœnenchym are polygonal in area.

A A. Calicles in various stages of formation.

Fig. 11. By the same. A calicle nearly fully developed, as seen when looked directly into. The calicle is surrounded by irregular dentations, of which there are more than twelve. A circlet of cœnenchymal tubes is seen to join the cavity of the calicle below.

## MADREPORARIA.—I. to XVI.

*Note.*—Those figures which represent enlarged views, are marked in the plates with the amount of magnification; the remainder of the figures are of the natural size of the objects represented. The locality at which each actual specimen figured was dredged is given in each instance.

### PLATE I.

Fig. 1. *Caryophyllia lævicostata.* *a* Mouth of the calicle of the same specimen. Off Ascension Island. 425 fathoms.

Fig. 2. *Caryophyllia clavus,* var. *transversalis.* *a* Mouth of the calicle of the same specimen. Off the Ki Islands. 129 fathoms.

Fig. 3. *Caryophyllia paucipalata.* *a* Mouth of the calicle of the same specimen. Off Culebra Island, Danish West Indies. 390 fathoms.

Fig. 4. *Caryophyllia communis.* *a* Mouth of the calicle of the same. Lat. 42° 8′ N., long. 63° 39′ W. 1250 fathoms.

Fig. 5. *Caryophyllia communis.* Lat. 37° 24′ N., long. 25° 13′ W. 1000 fathoms.

Fig. 6. *Caryophyllia profunda,* mass of examples fused together. *a* Mouth of one of the calicles of the same specimen. *b* Part of the wall of one of the calicles, to show the arrangement of the costæ. Off Nightingale Island, Tristan da Cunha group. 150 fathoms.

Fig. 7. *Caryophyllia lamellifera.* *a* The same enlarged. *b* Mouth of the calicle. Off the Kermadec Islands. 630 fathoms.

Fig. 8. *Caryophyllia rugosa.* *a* Mouth of the calicle of the same. *b* Portion of the wall enlarged to show the transverse lamellæ upon it. Off the Ki Islands. 129 fathoms.

### PLATE II.

Fig. 1 *Pleurocyathus brunneus,* attached by its side near the apex of its base to a fragment of volcanic rock. *a* The same enlarged, viewed from the side. *b* Mouth of the calicle of the same. *c* Portion of the wall of the calicle of the same,

much enlarged to show the arrangement of the costæ. Off Banda Island. 60 fathoms.

Fig. 2. *Deltocyathus agassizi*, the attached variety. *a*, *b* Views of the upper and under surfaces of the same enlarged. South Pacific Ocean. Lat. 32° 36′ S., long. 137° 43′ W. 2375 fathoms.

Fig. 3. *Deltocyathus agassizi*, attached variety. *a* The same enlarged. Off the Danish West Indies. 200 to 320 fathoms. Specimen received from Professor G. Lindström.

Fig. 4. *Odontocyathus coronatus*. *a* Under surface of the same. *b* Mouth of calicle. Off Culebra Island, Danish West Indies. 390 fathoms.

Fig. 5. Young specimen of *Odontocyathus coronatus*. *a* Mouth of calicle of the same. *b* Under surface of the same enlarged. Off Culebra Island, Danish West Indies. 390 fathoms.

Fig. 6. *Acanthocyathus spinicarens*. *a* View of the opposite surface of the same specimen. *b* Mouth of the calicle of the same. *c* Enlarged view of the costæ of the same. Off the Philippine Islands. Lat. 9° 26′ N., long. 123° 45′ E. 375 fathoms.

Fig. 7. *Acanthocyathus dentatus*. *a* View of the opposite surface of the same specimen. *b* Mouth of the calicle of the same. *c* Enlarged view of the costæ of the same. Off Kandavu, Fiji Islands. 210 fathoms.

Fig. 8. *Cyathoceras rubescens*, attached to a dead specimen of the same species; side view of the calicle. *a* View of the broader aspect or face of the calicle of the same specimen. *b* Mouth of the calicle. *c* Enlarged view of the costæ of the same. Off the Ki Islands. 126 fathoms.

## PLATE III.

Fig. 1. *Stephanotrochus diadema*. *a* Mouth of the calicle of the same. *b* Under surface of the same. *c* Tip of one of the exsert primary septa and its costa much magnified. Off Pernambuco, Brazil. 675 fathoms.

Fig. 2. *Stephanotrochus discoides*. *a* Under surface of the same. *b* Mouth of calicle. *c* Portion of the margin of the under surface of the same enlarged to show the form of the costæ. Off Pernambuco, Brazil. 675 fathoms.

Fig. 3. *Stephanotrochus nobilis*. *a* Under surface of the same. *b* Mouth of calicle. Off the Azores. Lat. 38° 30′ N., long. 31° 14′ W. 1000 fathoms.

Fig. 4. *Stephanotrochus platypus*. *a* Under surface of the same, showing in its centre a small Gasteropod shell to which the coral was primarilly attached. *b* Mouth of the calicle of the same. Off Sydney, New South Wales. 410 fathoms.

Fig. 5. *Stephanotrochus platypus*, a smaller specimen than the foregoing. *a* View of the under surface, showing in the centre an attachment to a small spiral shell. *b* Mouth of the calicle. *c* Tip of one of the exsert septa and its corresponding costa much enlarged. Off Sydney, New South Wales. 410 fathoms.

## PLATE IV.

Fig. 1–6. Young specimens of *Desmophyllum ingens*, showing various stages of growth. Patagonia. Lat. 52° 50′ S., long. 73° 53′ W. 245 fathoms.

Fig. 7. *Cyathoceras cornu*. *a* Mouth of the calicle. Off the Rio de la Plata. Lat. 37° 17′ S., long. 53° 52′ W. 600 fathoms.

Fig. 8. *Caryophyllia maculata*. *a* Mouth of the calicle of the same. Off Barra Grande, Brazil. 400 fathoms.

Fig. 9. *Caryophyllia maculata*, larger specimen than the foregoing, attached to a branch of a Stylasterid. Above 9 (with its number accidentally omitted in the plate), view of the mouth of the calicle of the same, enlarged three diameters. Off the Kermadec Islands. 630 fathoms.

Fig. 10. *Deltocyathus magnificus*. Under surface. Off the Ki Islands. 129 fathoms.

Fig. 11. *Stephanophyllia formosissima*. Under surface. Off the Ki Islands. 129 fathoms.

Fig. 12. *Stephanophyllia complicata*. Under surface. Off the Ki Islands. 129 fathoms.

## PLATE V.

Figs. 1–4. *Desmophyllum ingens*. Patagonia. Lat. 48° 18′ S., long. 74° 33′ W. 345 fathoms.

1. A specimen showing two examples of the largest size fused together laterally, with an attachment at the base to a fragment of a third example. *a* Mouth of the calicle of the upper example.
2. A somewhat deformed specimen, with roots at the base encrusting the skeleton of a Gorgonoid. *a* Mouth of the calicle of the same, showing one side distorted and bent inwards.
3. A cylindrical example, with numerous basal roots also adherent to the skeleton of a Gorgonoid. *a* Mouth of the calicle of the same.
4. Mass composed of numerous examples fused together reduced in size one-half. *a* View of the broken end of the lower part of one of the calicles to show the continuation of the septa within it, and absence of a columella.

## PLATE VI.

Fig. 1. *Desmophyllum eburneum.* Somewhat broken. *a* The broader face of the same. *b* Mouth of the calicle. Off Middle Island, Patagonia. 345 fathoms.

Fig. 2. *Flabellum angulare.* [*N.B.* By mistake, included in the legend at the foot of the plate under *Desmophyllum.*] *a* Under surface of the same. *b* Mouth of the calicle. Off Nova Scotia. Lat. 42° 8′ N., long. 63° 39′ W. 1250 fathoms.

Fig. 3. *Flabellum curvatum.* *a* Underneath view of the same specimen. *b* Mouth of calicle. *c* Side view of another specimen of the same. *a* View of the opposite face of the same. Off the Rio de la Plata. Lat. 37° 17′ S., long. 53° 52′ W. 600 fathoms.

Fig. 4. *Flabellum patens.* *a* Mouth of the calicle. Off the Ki Islands. 129 fathoms.

Fig. 5. *Flabellum patens,* a younger specimen. *a* Mouth of the calicle of the same. Off the Ki Islands. 129 fathoms.

Fig. 6. *Flabellum elongatum.* *a* Mouth of the calicle. Bass Straits, Australia. 38 fathoms.

Fig. 7. *Flabellum apertum.* *a* View of the same, tilted somewhat to show the mouth of the calicle. *b* Mouth of the calicle. *c* Under surface or the same. Off the Prince Edward Islands. 310 fathoms.

Fig. 8. *Sphenotrochus rubescens.* *a* Mouth of the calicle of the same. Off the Ki Islands. 129 fathoms.

## PLATE VII.

Fig. 1. *Flabellum alabastrum.* *a* Under surface of the same. *b* Mouth of the calicle. Off the Azores. 1000 fathoms.

Fig. 2. *Flabellum alabastrum,* very young specimen. *a* Mouth of the calicle of the same. *b* View of the interior of the calicle divided longitudinally. Off the Azores. 1000 fathoms.

Fig. 3. *Flabellum japonicum.* *a* Mouth of the calicle. Off Enosima, Japan. 345 fathoms.

Fig. 4. *Flabellum australe.* *a* Mouth of the calicle. Off Twofold Bay, New South Wales. 120 fathoms.

Fig. 5. *Flabellum australe,* young specimen. *a Flabellum australe,* younger specimen still. *b* Mouth of the calicle of the same. Off Twofold Bay, New South Wales. 120 fathoms,

Fig. 6. *Flabellum conus.* *a* Under surface of the same. *b* Mouth of the calicle. Off the Admiralty Islands. 1070 fathoms.

## PLATE VIII.

Figs. 1–6. *Bathelia candida.* Off the Mouth of the Rio de la Plata. 600 fathoms.

1. A large dead specimen, partly overgrown by various incrustations, and hence not showing the texture of the surface or other details ; figured to show the mode of branching.
2. Portion of a branch which was living when dredged.
3, 4. Enlarged views of fully-grown calicles.
5. Enlarged view of young calicle from the tip of a branch.
6. Portion of a branch much enlarged to show the costæ and striation of the surface.

Figs. 7, 8. *Lophohelia prolifera.* Off Sombrero Island, Danish West Indies. 450 fathoms.

7. A branch of the natural size.
8. Mouth of a calicle enlarged.

Figs, 9, 10. *Lophohelia arbuscula.*

10. Mouth of a calicle enlarged. Off Banda Island. 200 or 360 fathoms.

Figs. 11–14. *Lophohelia tenuis.* Off the Philippine Islands. 375 fathoms.

11. Fragment of a branch of the natural size.
12. Mouth of a calicle enlarged.
13. View of one side of the interior of a calicle to show the form of the septa.
14. Portion of the exterior of the wall of a calicle to show the costæ. This figure is very blurred and imperfect.

## PLATE IX.

Figs. 1–5. *Solenosmilia variabilis.* Off Ascension Island. 420 fathoms.

1. A massive example of the coral of the natural size.
2. One of its calicles enlarged.
3. A pair of young calicles from the tip of a branch to show the bigemmation and communication of the cavities of the two calicles.
4. A less massively grown specimen of the same coral.
5. A dead and worn specimen of a massive example of the same.

Figs. 6–13. *Lophohelia candida.* Off Sombrero Island, Danish West Indies. 450 fathoms.

6. An average specimen attached at its base to a bundle of spicules of *Hyalonema* which it encrusts.
7, 8. Mouths of calicles of the same specimen.

9. A very slender young specimen.
10. One of the calicles of the same.
11. Enlarged view of part of the surface of the same to show the striations.
12. An old and very massive specimen, much thickened by growth of cœnenchym.
13. Mouth of one of the calicles of the same.

## PLATE X.

Fig. 1. *Sphenophyllia flabellum.* *a* Under surface of the same. *b* Mouth of the calicle. Locality unknown.

Figs. 2, 3. *Tridacophyllia cervicornis.* Locality unknown.

2. *a* The same, enlarged view into the mouth of the calicle. *b* Tip of one of the processes of the margin of the calicle, viewed from the inner surface to show the septa. *c* Back of the same process.
3. A smaller specimen of the same coral. *a* View into the mouth of its calicle.

Fig. 4. *Astræa abyssorum.* *a* Enlarged view of a calicle of the same. Arafura Sea. 49 fathoms. At the foot of the plate the older term of MM. Milne-Edwards and Haime, *Siderastræa*, is printed by inadvertence.

Fig. 5. *Cladocora conferta.* *a* Enlarged view of a calicle of the same. Off Samboangan, Mindanao, Philippines. 30 fathoms.

Fig. 6. *Cycloseris tenuis.* *a* Under surface of the same. Off Tongatabu, Friendly Islands. 18 fathoms.

Fig. 7. *Neohelia porcellana.* *a* Enlarged view of a calicle of the same. Off Api Island, New Hebrides. 63 fathoms.

## PLATE XI.

Figs. 1–13. *Bathyactis symmetrica.* A series from various localities to show the variations in size and form.

1. A large specimen, upper surface twice the natural size. *a* Under surface of the same. Lat. 46° 16′ S., long. 48° 27′ E. 1600 fathoms. 80 miles west of Hog Island, Crozet Islands.
2. One of the largest specimens dredged. Lat. 36° 44′ S., long. 46° 16′ W. 2650 fathoms. South Atlantic Ocean, east of the Rio de la Plata.
3. Specimen showing a regular and symmetrical fusion of the upper margins of the inner parts of the septa as in *Deltocyathus.* Lat. 33° 31′ S., long. 74° 43′ W. 2160 fathoms. Between Juan Fernandez Island and Valparaiso.
4. Deformed specimen, which has been fractured and was reunited. Lat.

36° 44′ S., long. 46° 16′ W. 2650 fathoms. South Atlantic Ocean, east of the Rio de la Plata.

5. Specimen showing no fusion of the septa, but with the synapticulæ fairly developed. Same locality as the foregoing.
6. Specimen showing a complex transverse connection of the septa, and hypertrophy of synapticulæ, and a circular lamina of hard tissue in the centre. Lat. 35° 41′ N., long. 157° 42′ E. 2300 fathoms. North-West Pacific Ocean.
7. Specimen, showing a fusion of the septa, and in one of the deltoid spaces a development of cancellar hard tissue, but with very few synapticulæ. Lat. 36° 44′ S., long. 46° 16′ W. 2650 fathoms. South Atlantic Ocean, east of the Rio de la Plata.

8, 8*a*. Upper and under surface of a small adult specimen, showing very regular fusions of septa and synapticulæ. Off Bermuda. 1035 fathoms.

9, 9*a*. Deformed specimen, fractured and reunited. Off Bermuda. 32 fathoms.

10, 10*a*, and 11, 11*a*. Specimens dredged in lat. 13° 50′ S., long. 151° 49′ E. Off the north-east coast of Australia.

12, 12*a*. Minute adult specimen dredged in lat. 37° 29′ S., long. 27° 31′ W. 2200 fathoms. South Atlantic Ocean.

13, 13*a*. Smallest specimen obtained, dredged in lat. 38° 30′ N., long. 31° 14′ W. 1000 fathoms. Off the Azores.

## PLATE XII.

Figs. 1–3. *Heteropsammia multilobata*. Off Samboangan, Philippine Islands. 10 fathoms.

1. View of upper surface, showing the several calicles.
2. Side view, showing part of the under surface. At the bottom on the right is seen the aperture of the canal occupied by the sipunculid, and above, at the bases of the calicles, a row of pores by which this canal communicates with the interior.

Figs. 4–7. *Balanophyllia bairdiana*. Bass Strait, Australia. 38 fathoms.

5. Mouth of the calicle of the same.
6. Young specimen of the same.
7. Interior of the calicle of foregoing, much enlarged.

Figs. 8–10. *Thecopsammia elongata*, attached to a fragment of a *Balanophyllia*. Off the Admiralty Islands. 150 fathoms.

9. Mouth of the calicle.
10. Enlarged view of the outer surface.

Figs. 11–15. *Balanophyllia cornu.* Off the Ki Islands. 126 fathoms.

11. Large adult specimen, dead when dredged.
12. Mouth of the calicle of the same.
13. Part of the outer surface of the wall of the same at the margin of the calicle, enlarged to show the costæ.
14. Two younger specimens attached to the top of a dead adult calicle of the same species.
15. Mouth of the calicle of one of these.

## PLATE XIII.

(from Drawings by Dr J. J. Wild.)

Figs. 1, 2. *Deltocyathus magnificus.* Off the Ki Islands. 129 fathoms.

1. Upper surface.
2. The corallum viewed on edge, so as to show partly the under surface.

[*N.B.*—For a view of the under surface of the corallum see Plate IV.]

Figs. 3–5. *Stephanophyllia complicata.* From the same locality as the foregoing.

3. An adult specimen, upper surface.
4. A young specimen, upper surface, much magnified.
5. The same under surface.

[*N.B.*—For a view of the under surface of the adult corallum see Plate IV.]

Figs. 6, 7. *Stephanophyllia formosissima.* From the same locality as the foregoing.

6. Upper surface.
7. The same corallum viewed on edge.

[*N.B.*—For a view of the under surface of the corallum see Plate IV.]

## PLATE XIV.

(From Drawings by Dr J. J. Wild.)

Figs. 1–4. *Leptopenus discus.* Lat. 35° 39′ S., long. 50° 47′ W. 1900 fathoms.

1. Upper surface of a somewhat imperfect specimen.
2. Under surface of the same.

[*N.B.*—In both these figures only 71 marginal costal spikes are shown, there should have been 72, as in the specimens.]

3. The same seen edgewise, showing the upper surface in perspective.
4. Enlarged view of the under surface of a segment of the same corallum, near the margin, to show the alternation of the costæ with the septa.

Figs. 5, 6. *Leptopenus hypocælus.* Off Valparaiso. Lat. 33° 31′ S., long. 74° 43′ W. 2160 fathoms.

5. The corallum viewed directly from the upper surface.
6. The same viewed from the side.

## PLATE XV.

Figs. 1–7, 1*a*–7*a*. *Flabellum Patagonichum*, showing the adult corallum, and a series of stages in its growth. Off Penguin Island, Patagonia. 120 fathoms.

Fig. 8. *Thecopsammia gemma.* *a* Calicle of the same enlarged six diameters. *b* Portion of the wall of the same much enlarged, to show the epitheca. Basilan Strait, Philippine Islands. 102 fathoms.

Fig. 9. *Balanophyllia parvula*, of the natural size. *a* The same viewed directly into the mouth of the calicle, enlarged five diameters. Off the Ki Islands. 129 fathoms.

Fig. 10. *Balanophyllia rediviva*, of the natural size. *a* Calicle of the same enlarged three diameters. *b* Part of the wall of the same much enlarged.

Fig. 11. Dead worn specimen of the same of the natural size.

Fig. 12. Dead worn specimen of the same of very different form, also of the natural size. All the above off the Ki Islands. 129 fathoms.

## PLATE XVI.

Fig. 1. *Leptopenus discus.* Diagrammatic representation of the under surface, enlarged to show the mutual arrangements of the branching costæ and septa. The costæ are represented as white, the septa seen beneath them as black. *a*, *b* to *e* denote the septa of successive orders, *a* denoting the primary. Of the perforations of the wall only those lying near the centre of the corallum are indicated.

Fig. 2. The same. A similar scheme of the upper surface, to show the arrangement of the septa, and of the paliform spines which they bear. The spines situate near the centre of the corallum, being viewed directly from above, appear as small circular dots only, *a*, *a* primary septa, *b*, *c*, *d* septa of successive order.

Fig. 3. The same. To show the relation of the septa to the tentacles of the living coral. The septa are shaded black, and their successive orders indicated as before, by letters.

Fig. 4. The same. A diagrammatic section through the living coral to show the form of the soft parts, and the arrangement of the tentacles of the three kinds.

Fig. 5. The same. Portion of the under surface of the corallum much enlarged, to show the nature of the perforations and the relations of the costæ and septa to them. On either hand is seen one of the costæ. The two costæ are connected

by a series of transverse bars, between which lie more or less reniform depressions. The bottoms of these reniform depressions are traversed in their centres by the under edge of a septum, on either side of which is an oval perforation.

Fig. 6. The same. Portion of the upper surface of the wall of the corallum near its margin to show the arrangements of the perforations. Two series of perforations are shown. The perforations are disposed in pairs on either side of each septum. At the bottom of the figure the commencement of two septa are shown. The wall is folded, so as to rise on either hand towards the lines of origin of the septa, thus forming a series of low ridge-like elevations, separated by corresponding lines of depression or valleys, the bottoms of which correspond with the costæ.

Fig. 7. The same. Diagrammatic representation of one of the septa seen from its side to show the arrangement on the septal margin of the paliform spines, and the indented lower border of septum. The indentations correspond in position with the depressions seen in fig. 5.

Fig. 8. *Stephanophyllia formosissima.* The coral with the soft parts *in situ* to show the arrangement of the tentacles. On the right hand side the primary (1) and secondary (2) septa are indicated by lines to show the position of the tentacles with regard to them. Enlarged 2 diameters.

Fig. 9. The same. Vertical section through the soft parts of a decalcified specimen.

A, A. Apertures in the basal tissue, through which passed in the living state of the coral the transverse bars of the perforated wall of the corallum.

B, B. Apertures in the mesenteries.

C. Spongy mass of soft tissue covering the columella.

D. Œsophagus.

S. Stomach-cavity bounded by the edges of the mesenteries, each bearing mesenterial filaments.

E. Principal or primary mesentery, showing the arrangement of muscular fibres upon it.

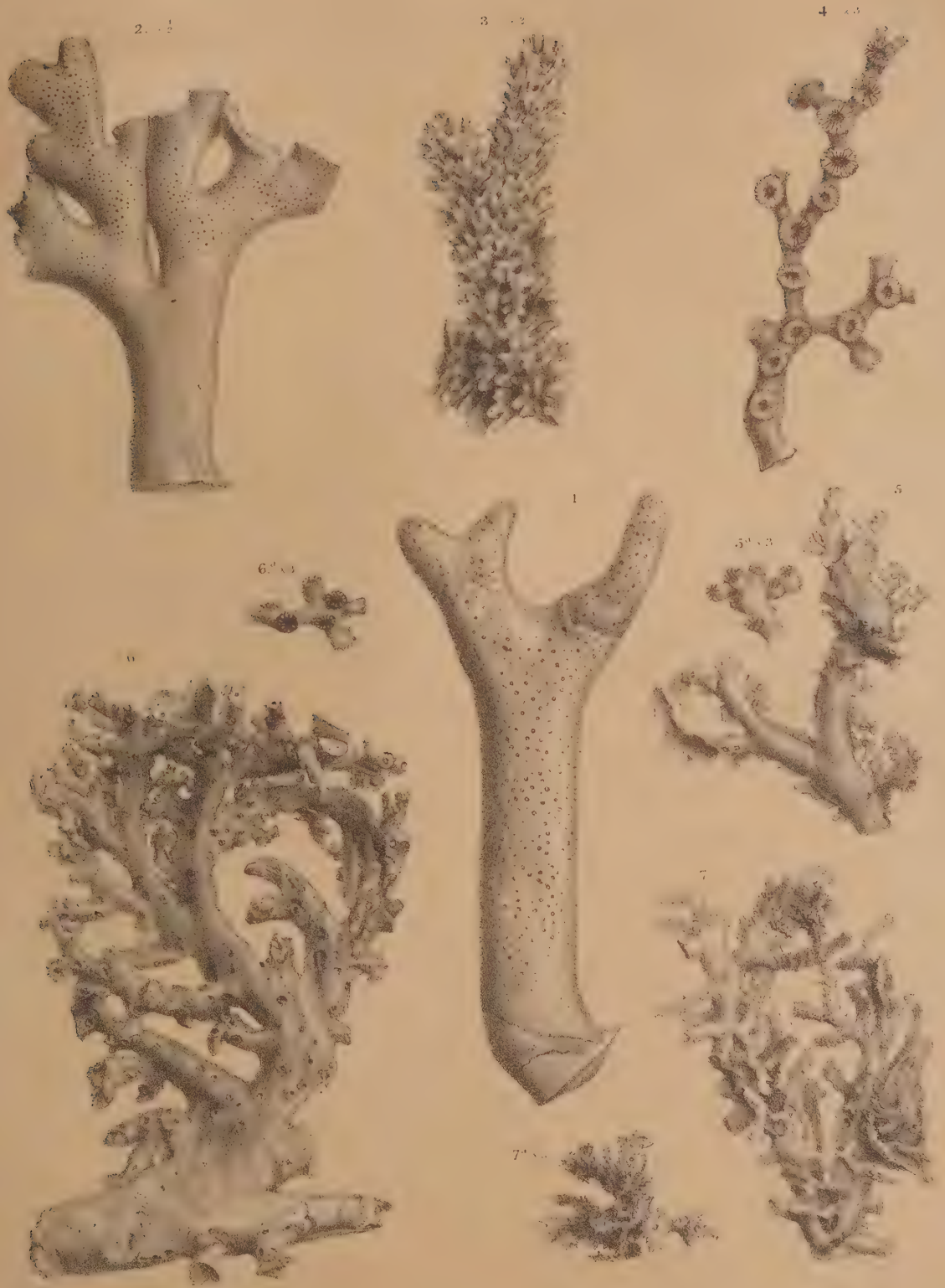
O, O. Ova.

Fig. 10. Diagrammatic representation of the mutual arrangement of the hard and soft parts in *Flabellum*, as seen in a section of a portion of it cut transversely to the vertical axis. The several layers are indicated by the shading throughout, the corallum being represented as black; E. Ectoderm; EN. Endoderm; B. Mesoderm; W. Wall of the corallum; S, S. Septa; M, M. Mesenteries; A, A. Muscles of the mesenteries; MF. Mesenterial filaments; T. A. tentacle.

Fig. 11. *Flabellum alabastrum.* Soft parts seen in a vertical section of one lateral half of the coral.

M. Mouth leading to the stomach. 1, 2, 3 Mesenteries of those orders, with their attached filaments, muscles, and ova. The positions of the margins of the septa of those orders are represented by fine curved dark lines. The wall of the corallum is seen in section *in situ.*

Fig. 12. Arrangement of the tentacles with regard to the septa in *Flabellum japonicum.* 1, 2, 3, 4 Primary, secondary, tertiary, and quarternary septa, at the inner margins of which are seen the corresponding peculiarly-shaped tentacles.



J.Erxleben ad nat lith.

1, 2 SPORADOPORA. 4 ASTYLUS. 6 ALLOPORA.
3 SPINIPORA. 5 STYLASTER. 7 ERRINA.

Figure 3.

Figure 4. × 40.

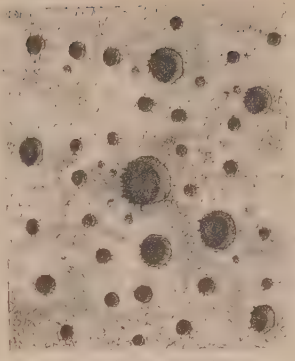


Figure 2. × 10.

Figure 7.

Figure 8.

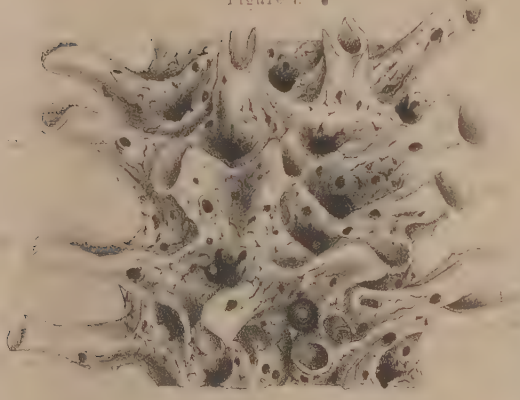


Figure 1. × 7.

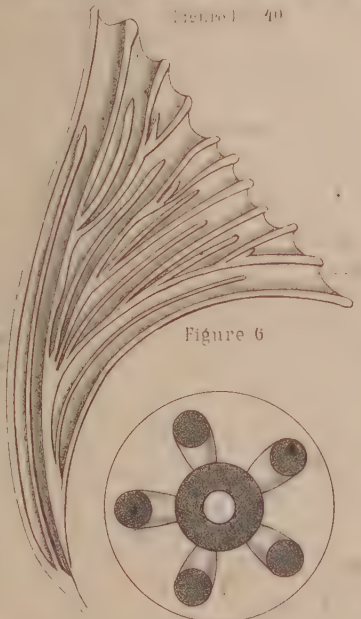


Figure 6.



Figure 11.

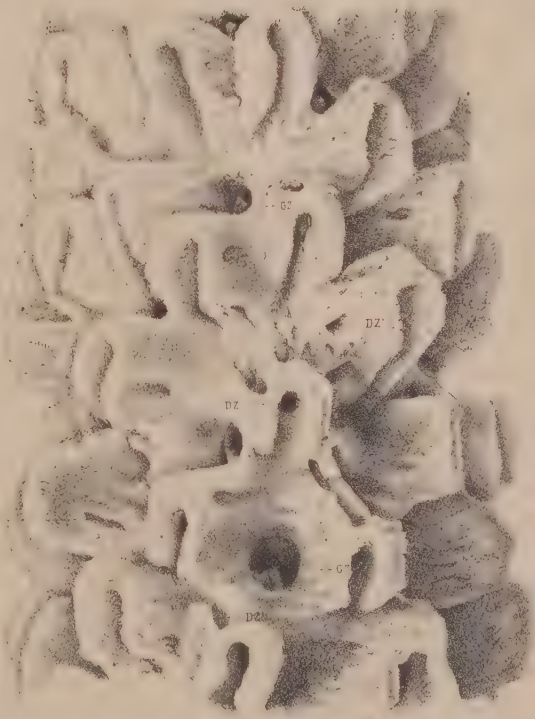


Figure 5. × 16.

Figure 9.

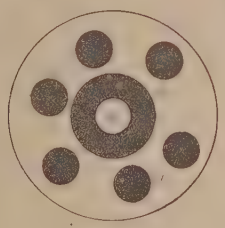


Figure 10.

Figure 12.

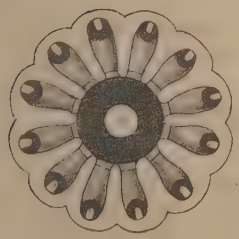


Figure 13.

Figure 14.

Figure 15.

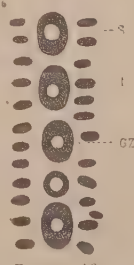



Figure 16.

H.N. Moseley & Stewart del.

Lith. Anst. v. J. G. Bach, Leipzig.

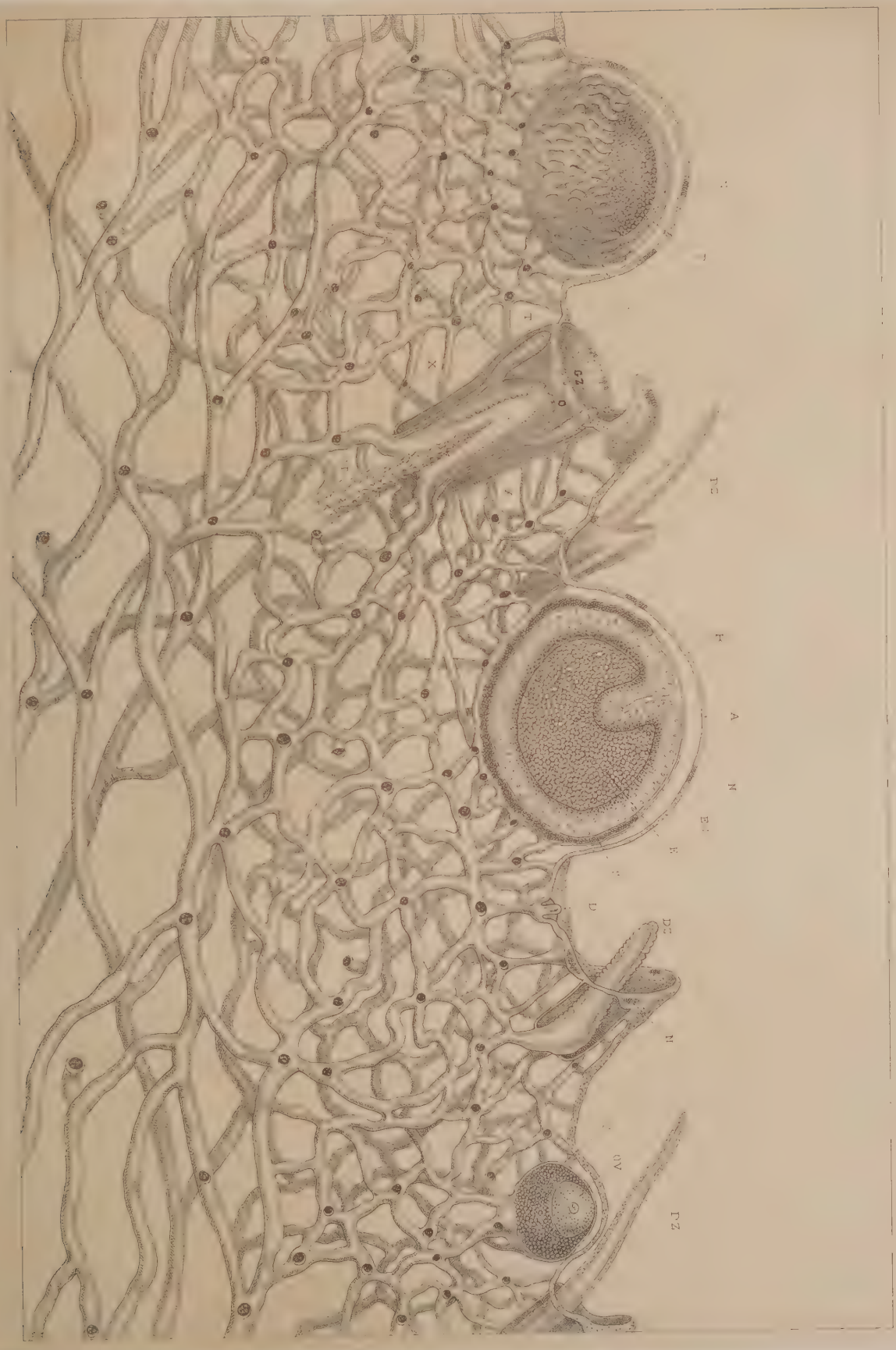
1, 2, 9, SPORADOPORA. 3, 13, 14, STYLASTER. 7, CRYPTOHELIA. 8, 15, ASTYLUS. 4, SPINIPORA.
5, LABIOPORA. 6, 16, DISTICHOPORA 10, 11, 12, ALLOPORA.

Sporadopora dictyon. X60

H N Moseley, del. J Erxleben, lith

SPORADOPORA.

Hanhart imp

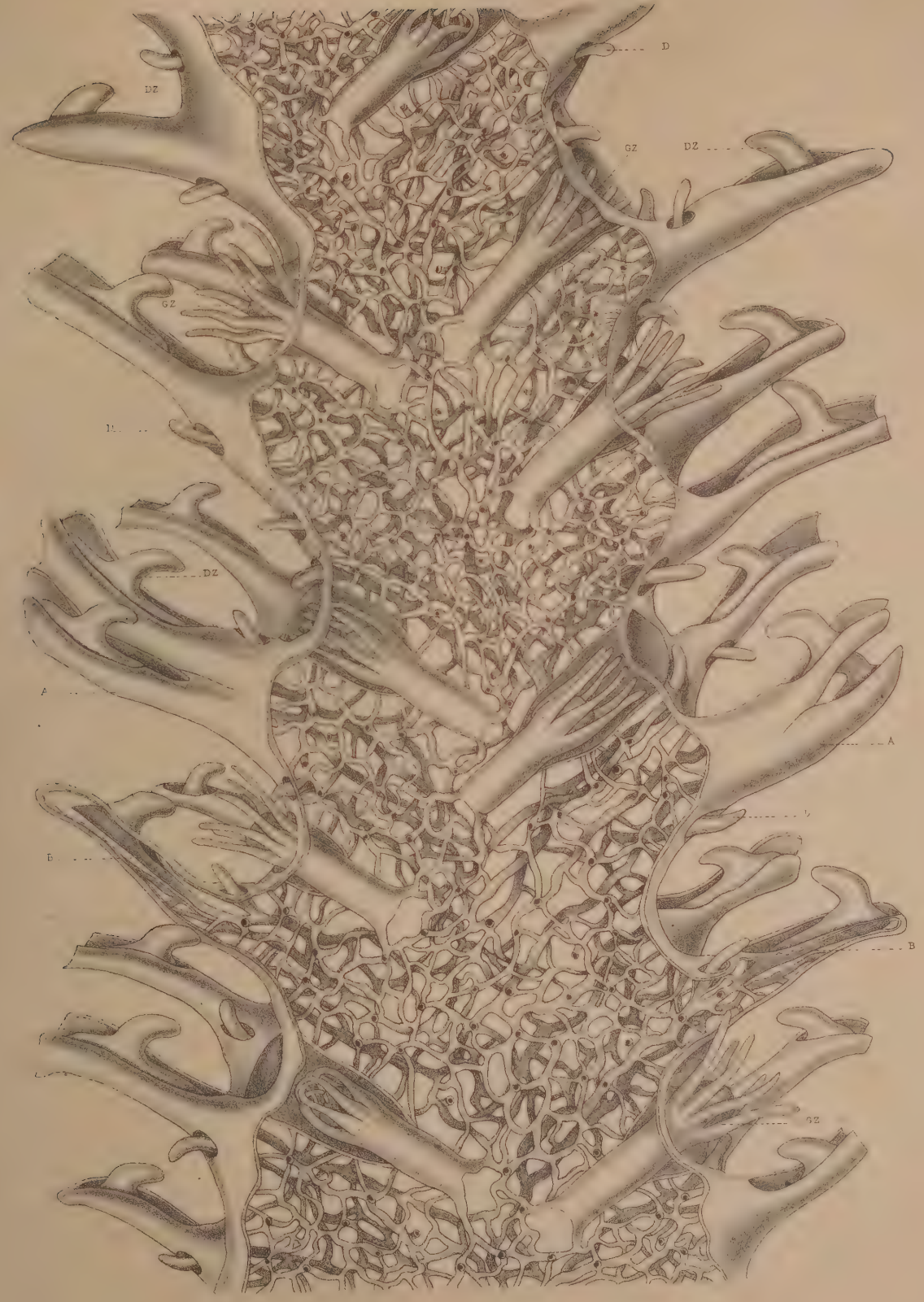


Errina labiata × 10.

H. N. Moseley, del.

F. Huth, Lith. Edin.

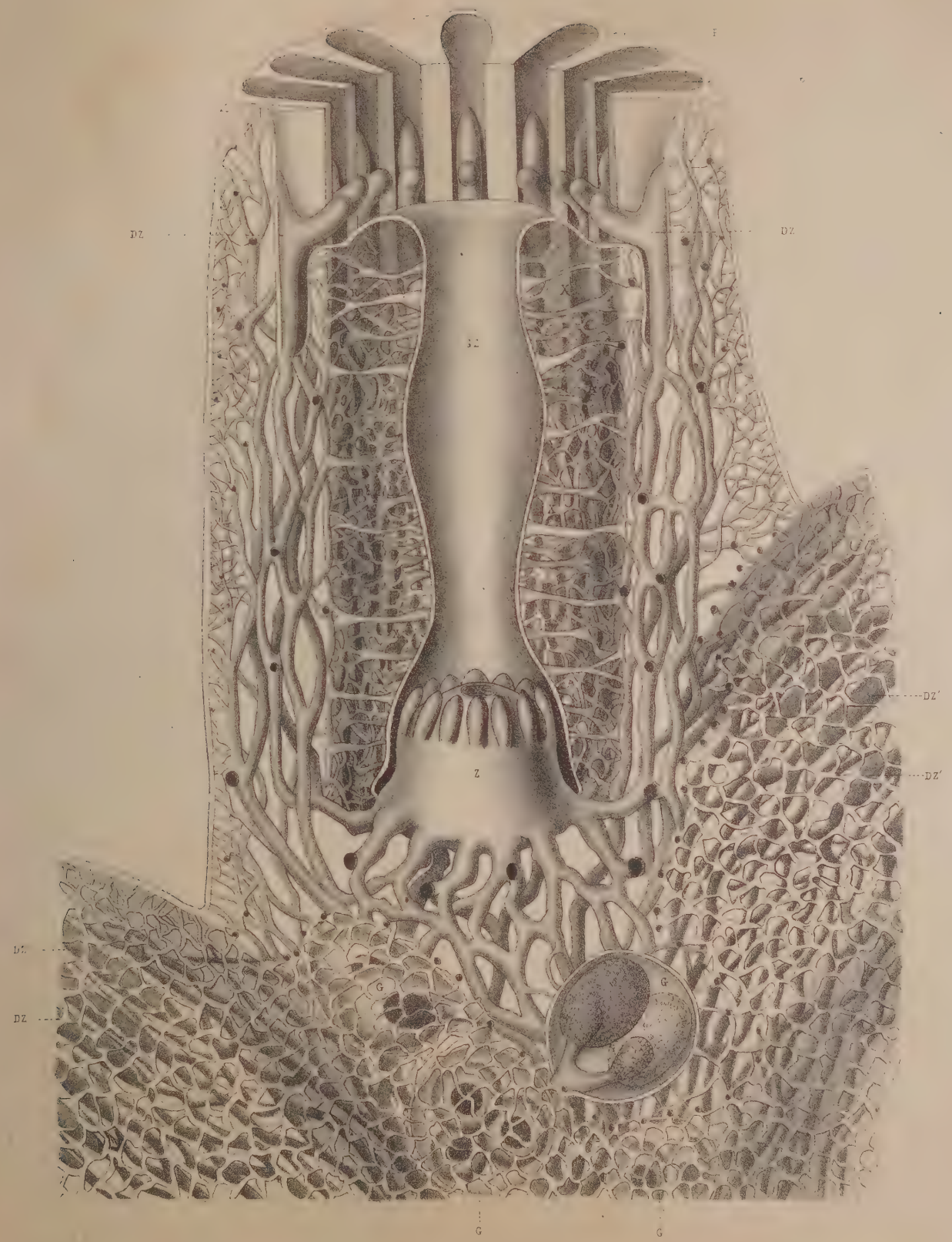
ERRINA.




H.N. Moseley del

SPINIPORA ECHINATA. × 15.

Lith. Anst. v. Gebr. Lach, Leipzig




ALLOPORA PROFUNDA × 60.

Stylaster densicaulis × 60

H.N. Moseley, del^t. F. Huth, Lith^r Edin^t

STYLASTER.

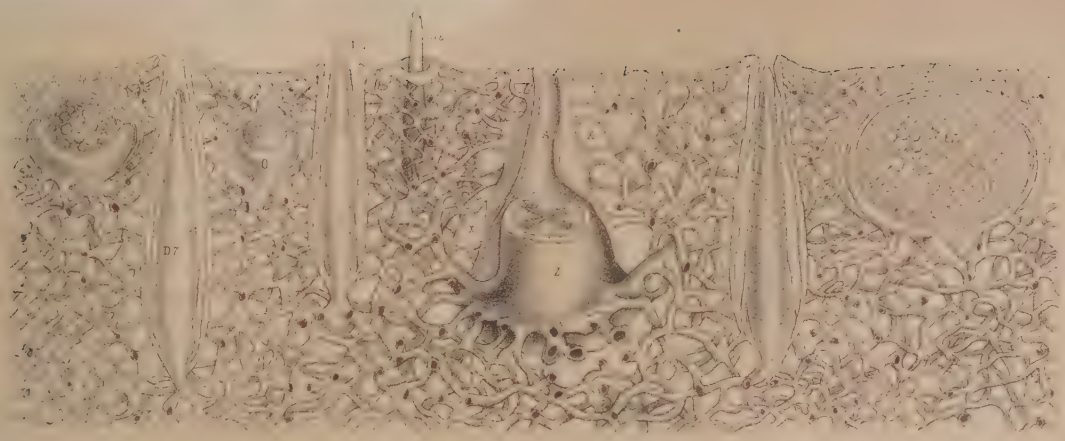
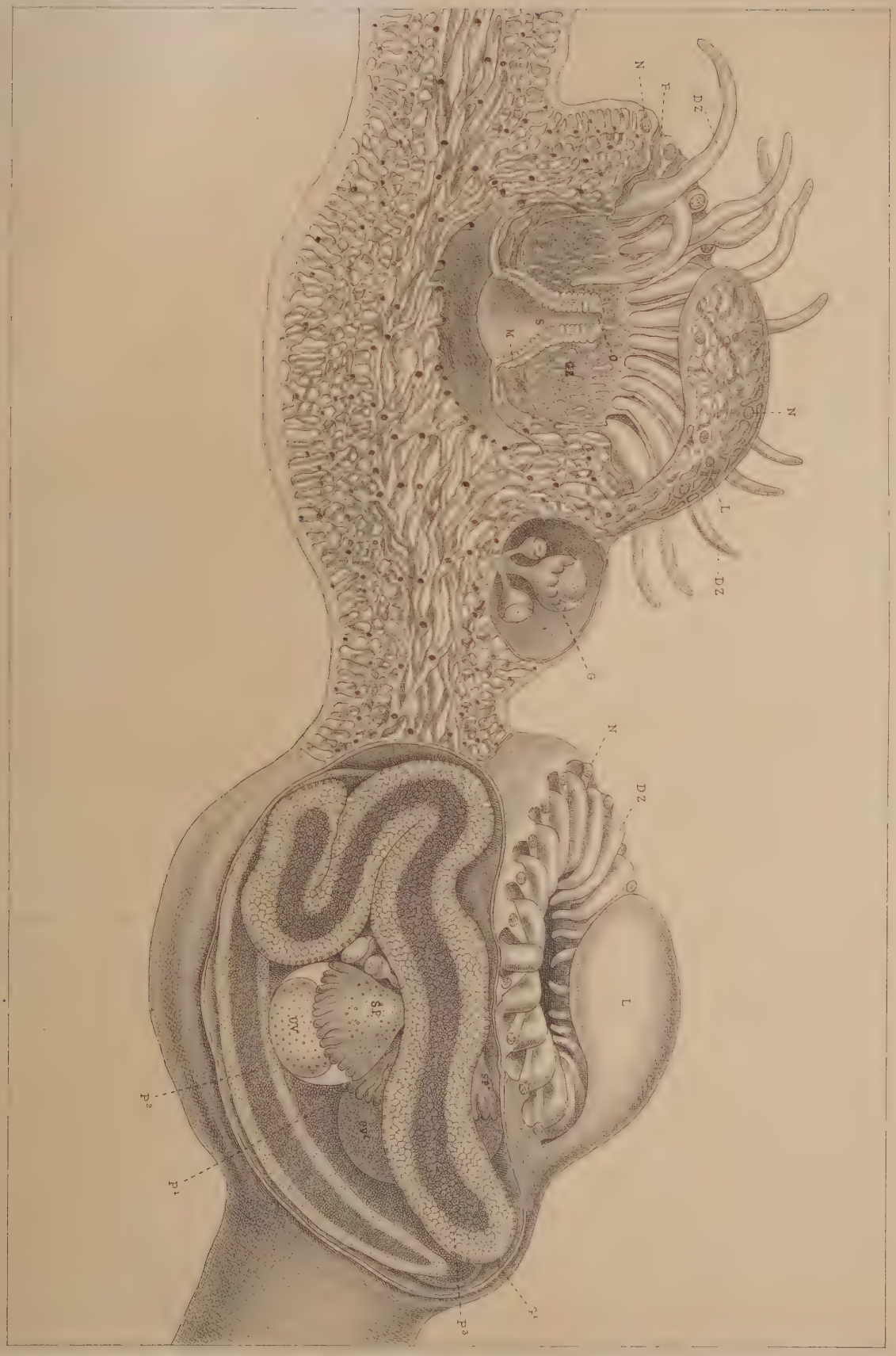


Figure 2. Pliobothrus symmetricus. × 50.

Figure 3. × 50.

Figure 1. Astylus subviridis × 40.




Cryptohelia affinis × 30.

H. N. Moseley, del.

F. Huth, Lith. Edin.

CRYPTOHELIA.

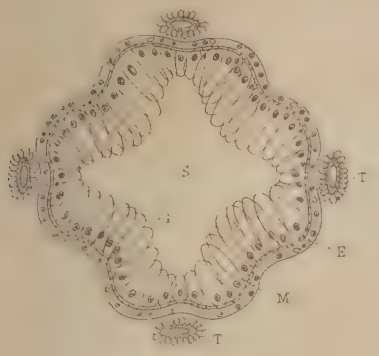



Fig. 1. × 85.

Fig. 3. × 70.

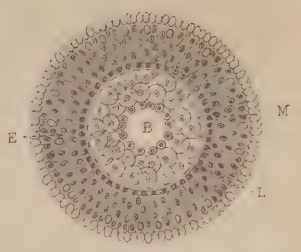



Fig. 2. × 86.

Fig. 4.

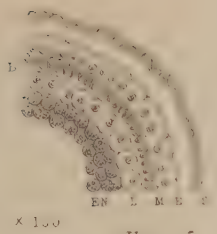



Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

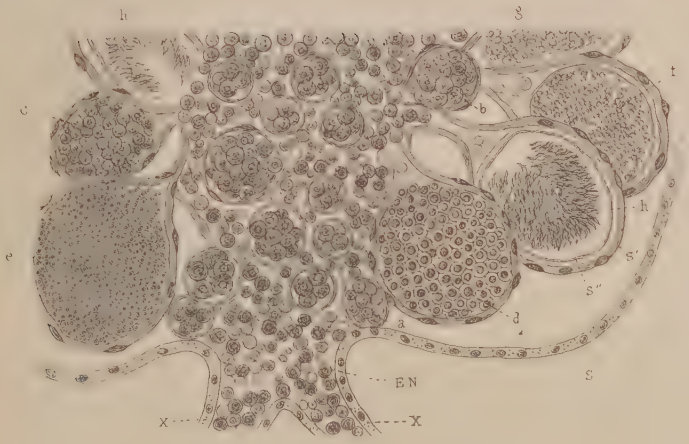



Fig. 10. × 300.

Fig. 9.

Fig. 11.

× 900.

Fig. 12.

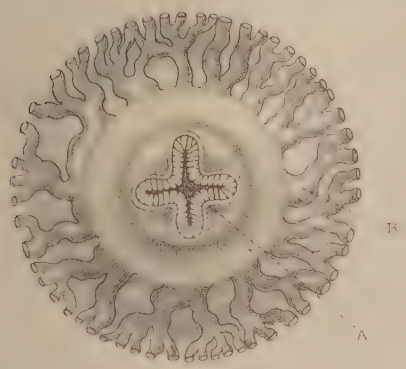



Fig. 1. × .

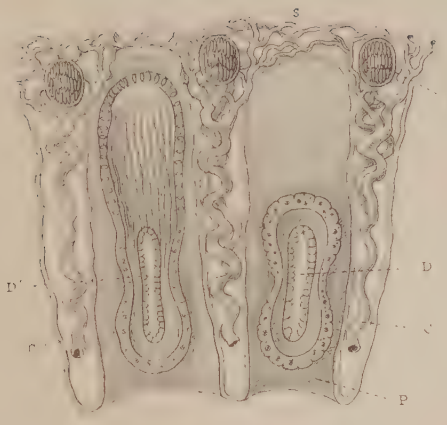



Fig. 2. × .

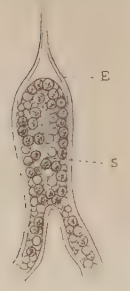



Fig. 3.

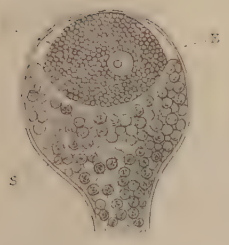



Fig. 4 × .

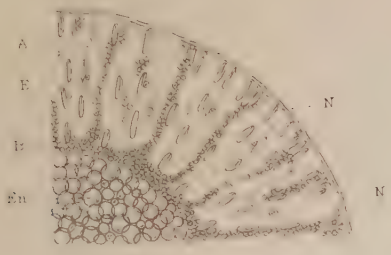



Fig. 7 × .

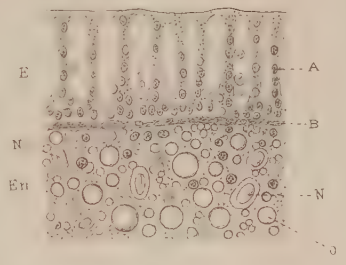



Fig. 9. × 150.

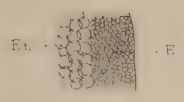



Fig. 5 × .

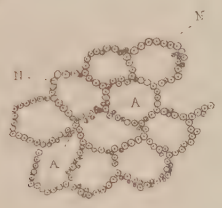



Fig. 8 × 120.

Fig. 10. × 200.

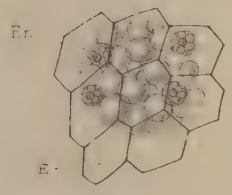



Fig. 6 × 200.

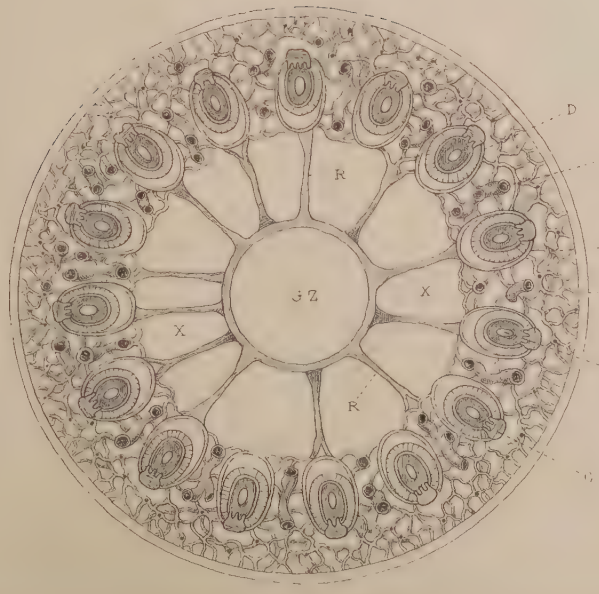



Fig. 12. × 50.

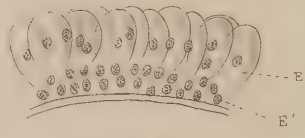



Fig. 11. × 200.

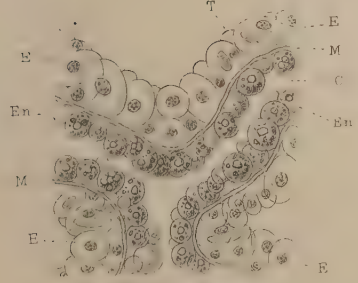



Fig. 13 × 300.

Fig. 14. × 900.

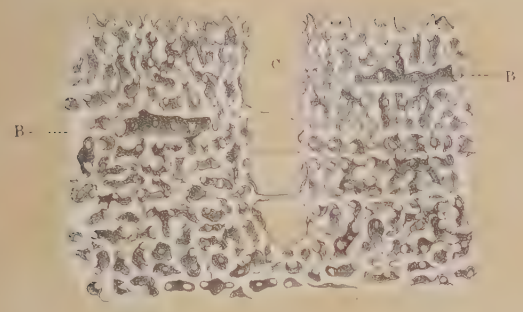
H.N.Moseley, del.

F.Huth, Lith. Edin.

ASTYLUS. CRYPTOHELIA ALLOPORA ERRINA.

Purkiss ad nat. lith. Hanhart imp

1_4. STENOHELIA. 7 CRYPTOHELIA
5,6. CONOPORA. 8. DISTICHOPORA.

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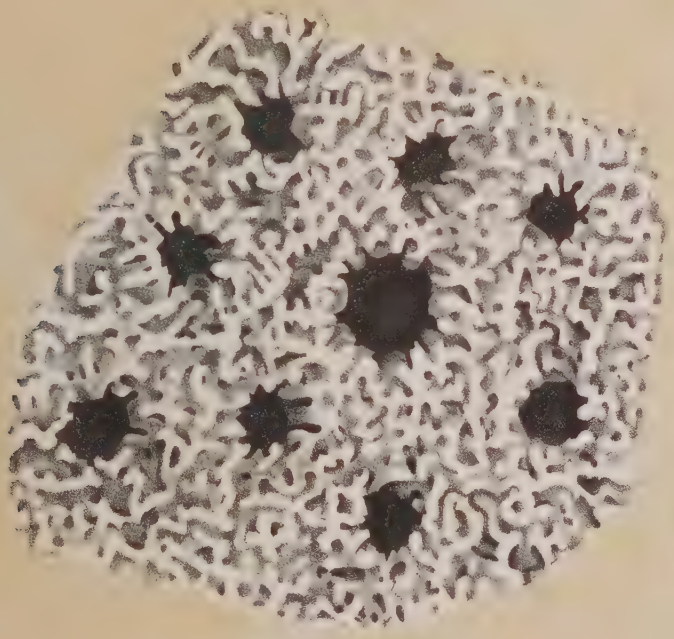

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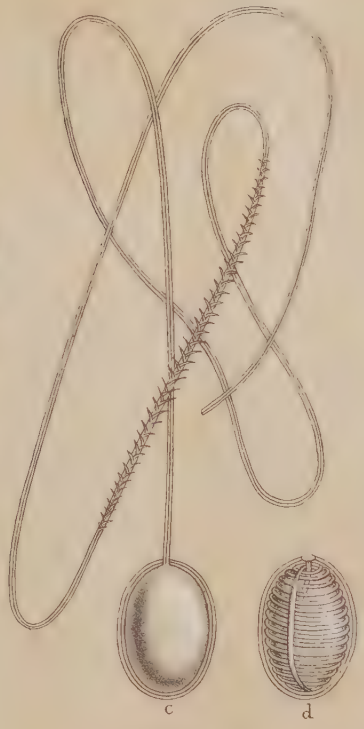


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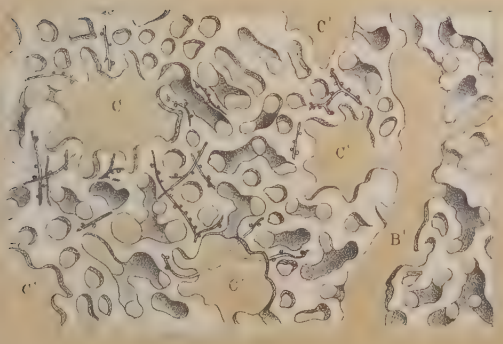


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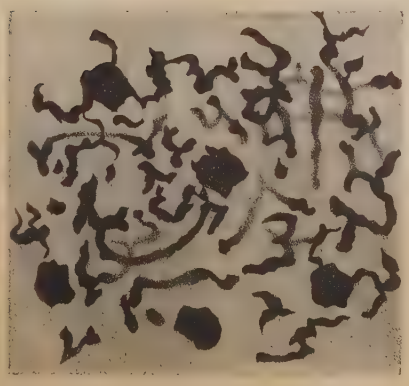

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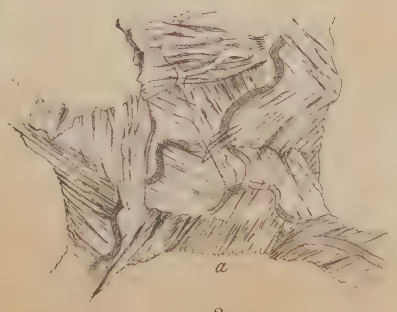
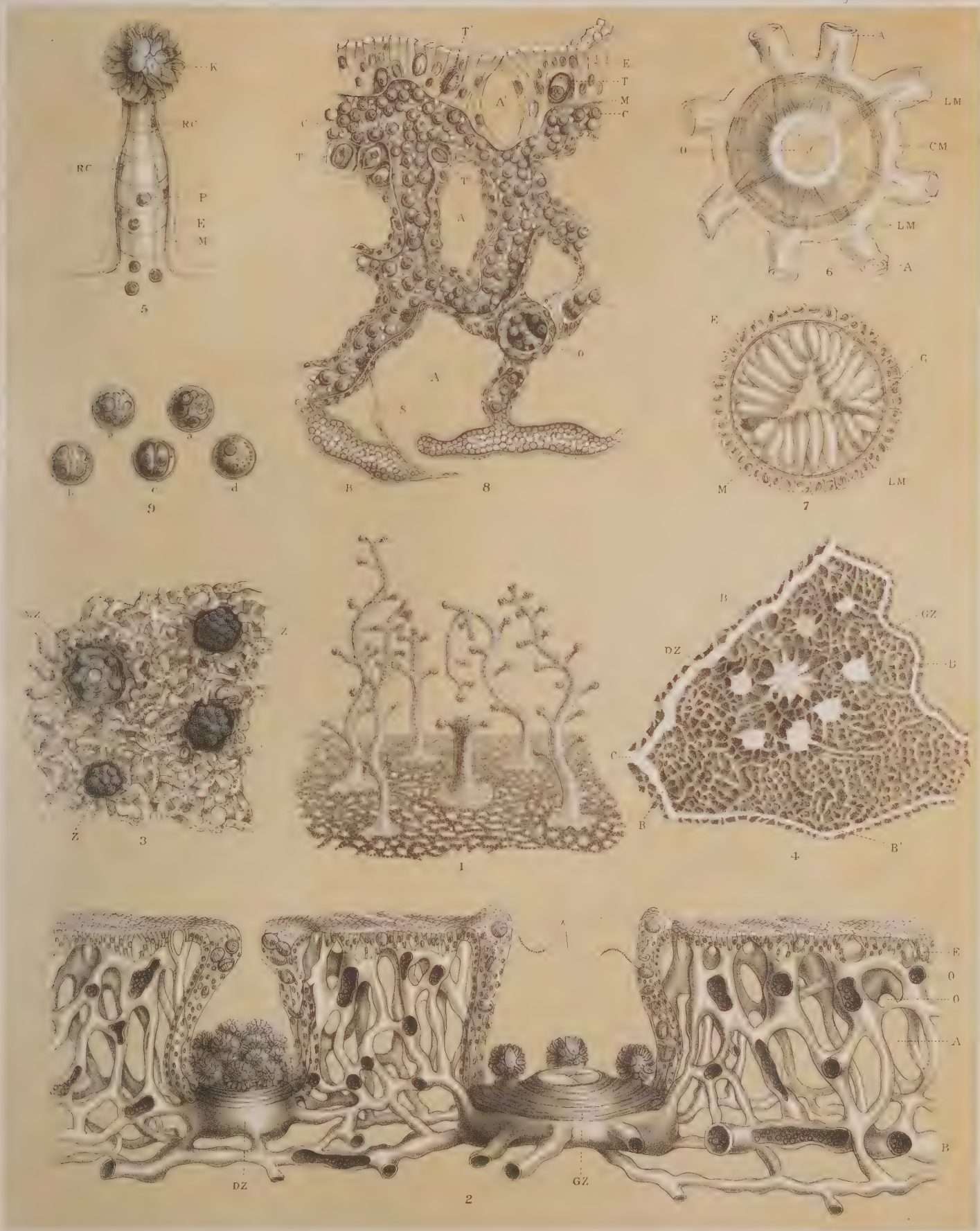



8



MILLEPORA.




H.N.Moseley del.

Hanhart lith.

MILLEPORA.

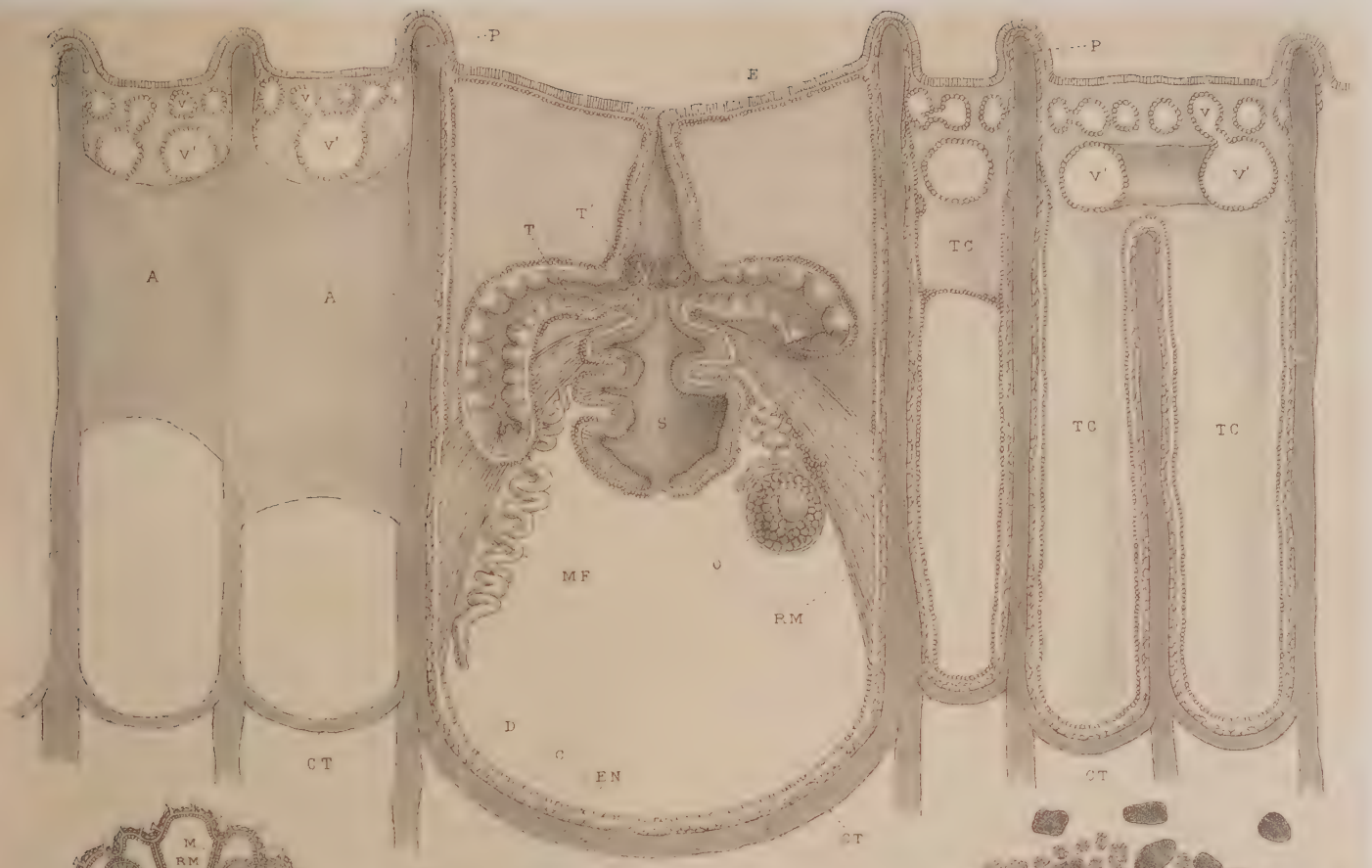



Fig. 1. × 42

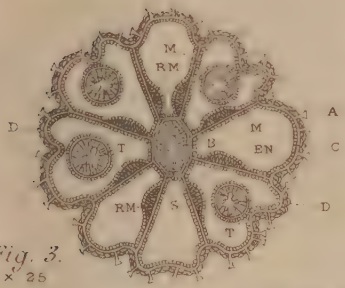



Fig. 3. × 25

Fig. 6. × 200

Fig. 5. × 25.

Fig. 2. × 11.

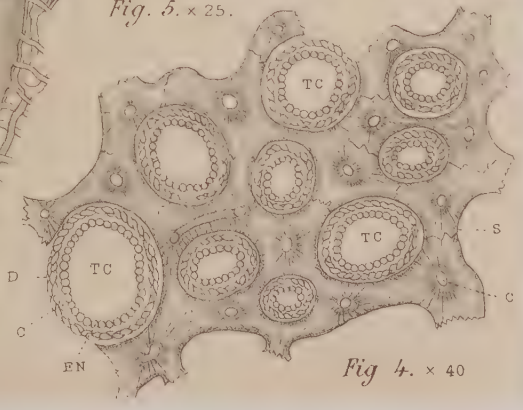



Fig 4. × 40

H N.Moseley, del. F. Huth, Lith^r Edin^r

HELIOPORA. SARCOPHYTON.

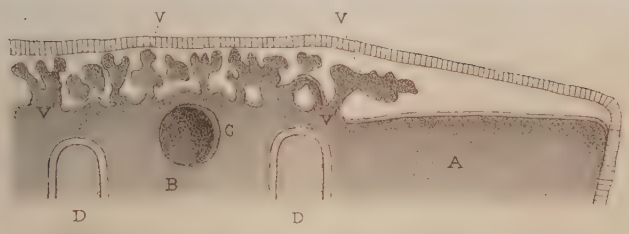



*Fig. 1.*

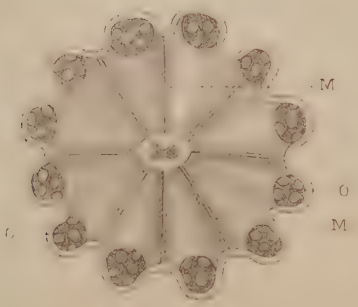



*Fig. 2.* × 30.

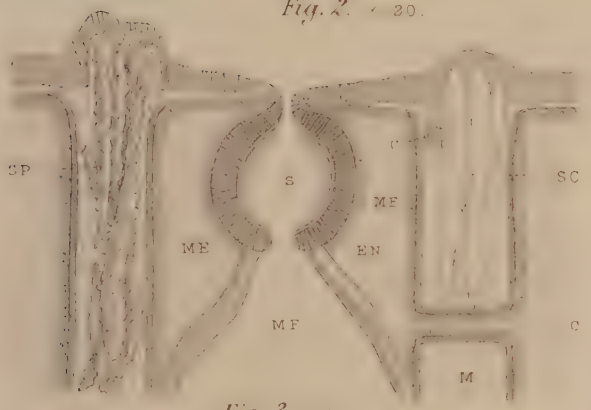



*Fig. 3.* × 6[illegible].

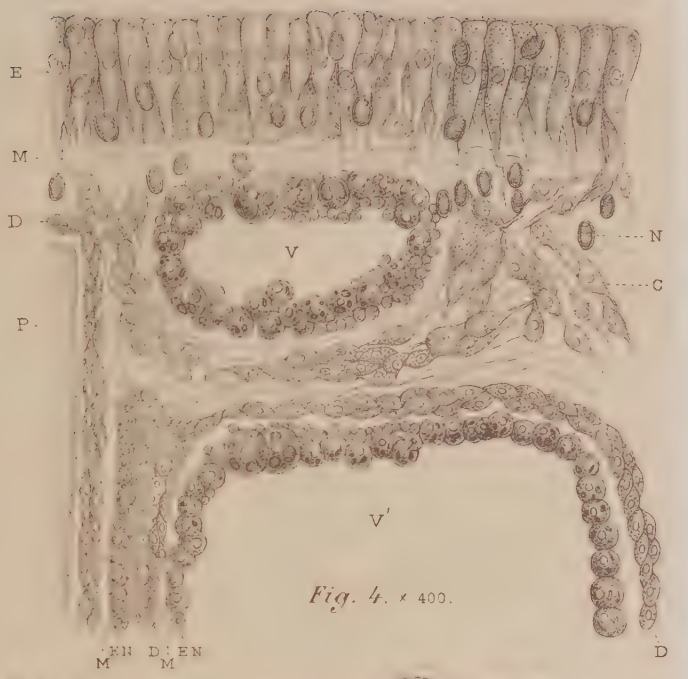



*Fig. 4.* × 400.

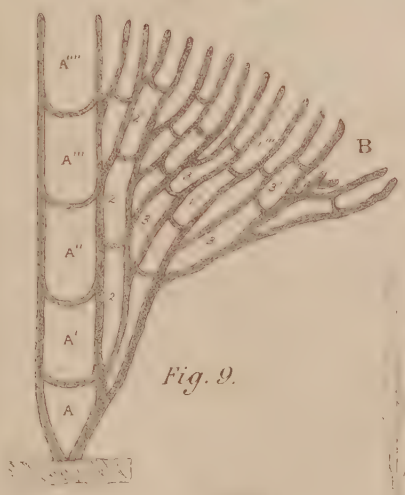



*Fig. 9.*

*Fig. 7.*
*a* × 670. *b* × 830.

*Fig. 5* × 7[illegible].

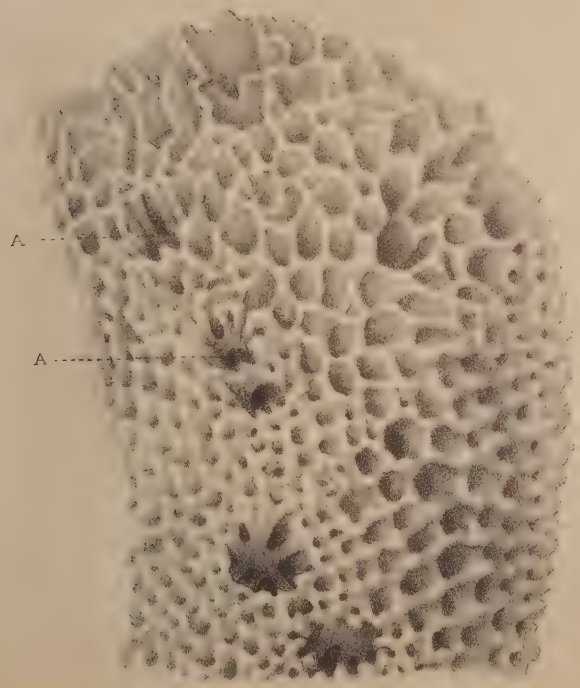



*Fig. 10.* × 8.

*Fig. 8.* × 80

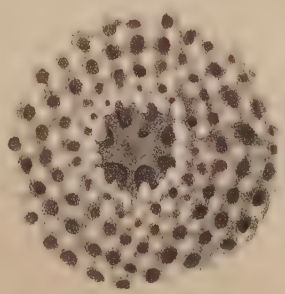


*Fig. 11.* × 10.

*Fig. 6.* × 250.

H.N. Moseley & J.J. Wild, del.

F Huth, Lith^r Edin^r

HELIOPORA. SARCOPHYTON.

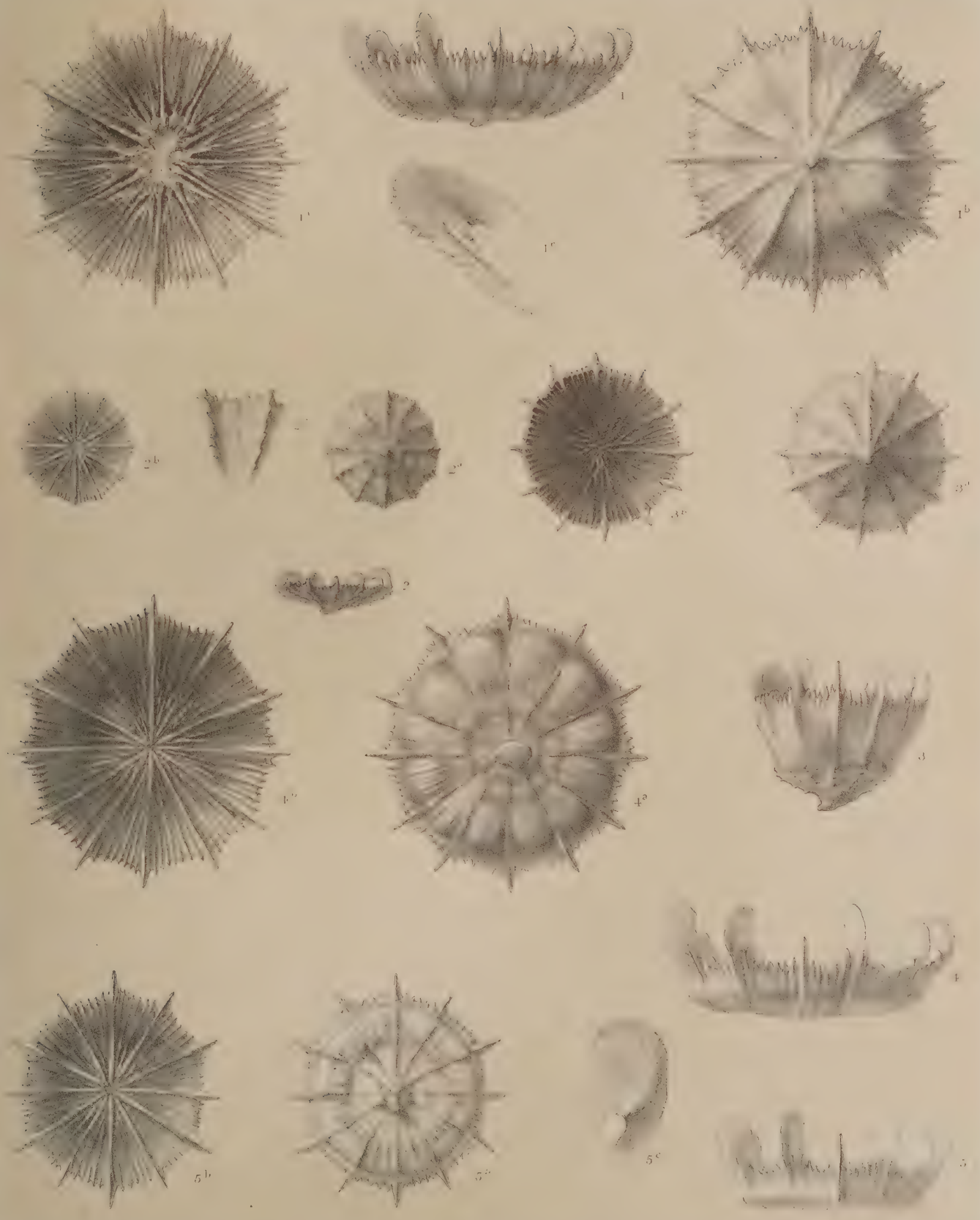
C.L.Griesbach del et lith

CARYOPHYLLIA.

Hanhart imp

Purkiss ad nat lith. Hanhart imp

1. PLEUROCYATHUS. 4,5. ODONTOTROCHUS.
2,3. DELTOCYATHUS. 6,7. ACANTHOCYATHUS.
8. CYATHOCERAS.



C.L.Griesbach del.et lith.

Hanhart imp.

. STEPHANOTROCHUS.

Purkiss del. et lith.. Hanhart imp

1-6. DESMOPHYLLUM. 7. CYATHOCERAS. 8,9. CARYOPHYLLIA.
10. DELTOCYATHUS. 11,12. STEPHANOPHYLLIA.

J Erxleben del et lith.

DESMOPHYLLUM.

Ha

Berjeau del et lith.

Hanhart imp

1 2 DESMOPHYLLUM. 3–7 FLABELLUM 8 SPHENOTROCHUS.

Berjeau del. et lith.

FLABELLUM.

Hanhart imp

J. Eyzleben, ad nat. lith.

1–6 BATHELIA. 7–14. LOPHOHELIA.

Hanhart imp.

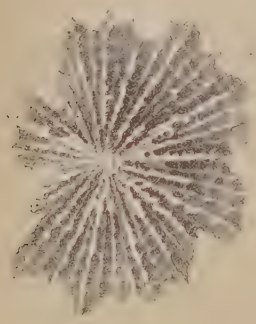
1-5 SOLENOSMILIA 6-13 LOPHOHELIA

Durkiss del et lith.

1. SPHENOPHYLLIA. 4. SIDERASTRÆA. 6. CYCLOSERIS.
2,3. TRIDACOPHYLLIA. 5. CLADOCORA. 7. NEOHELIA.

Hanhart imp

1a × 2



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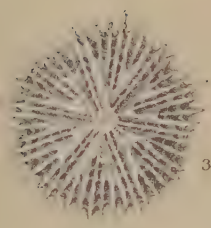

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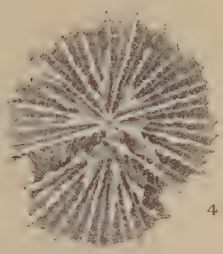
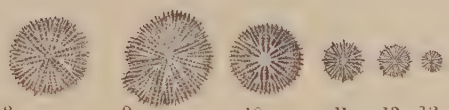
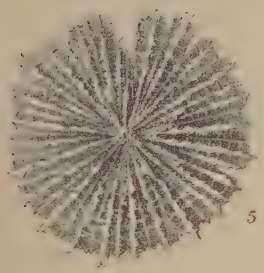


4

8a 9a 10a 11a 12a 13a



8 9 10 11 12 13



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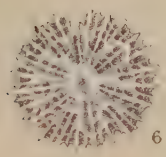


6

1 × 2

7

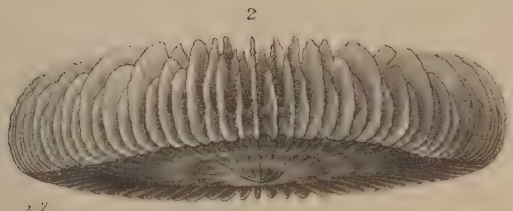
Purkiss del et lith.

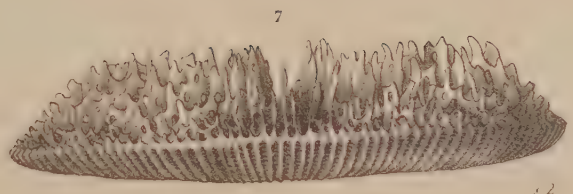
BATHYACTIS.

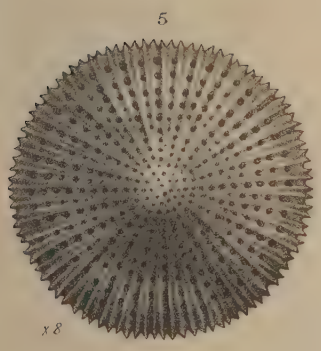
Hanhart imp

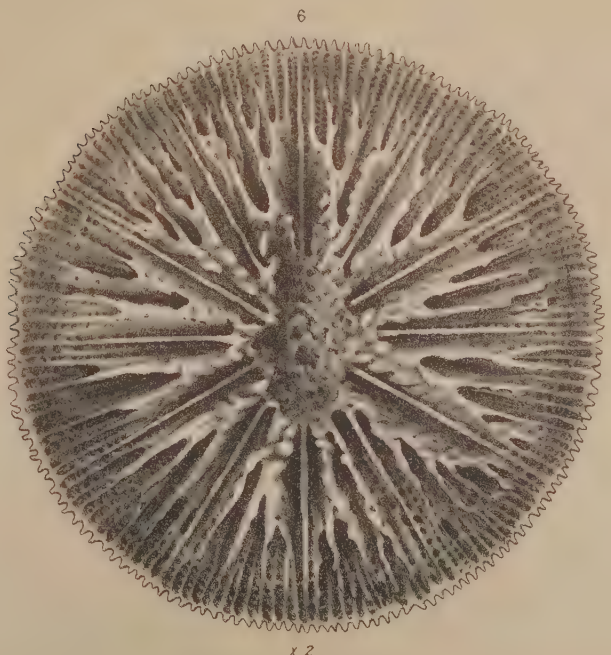
J.Erxleben del. et lith. Hanhart imp.

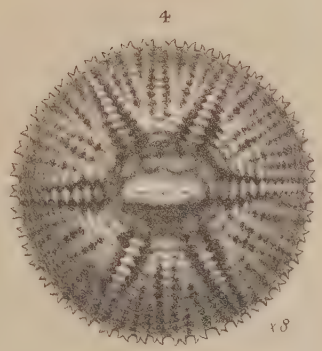
1_3 HETEROPSAMMIA. 4_7. 11_15. BALANOPHYLLIA.
8_10. THECOPSAMMIA.



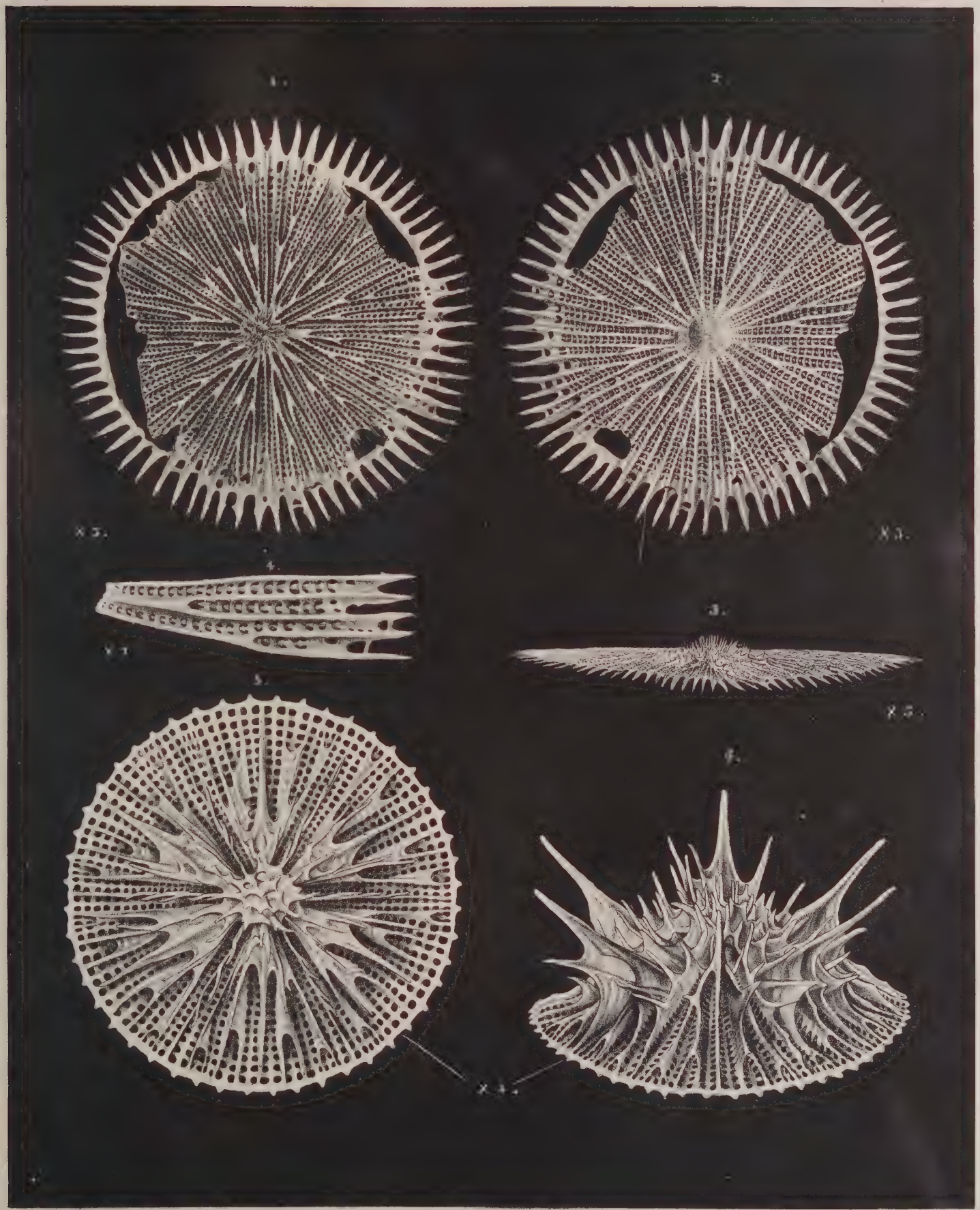




J.J.Wild ad nat. del. C.L.Griesbach lith

Hanhart imp

1.2. DELTOCYATHUS. 3–7. STEPHANOPHYLLIA.



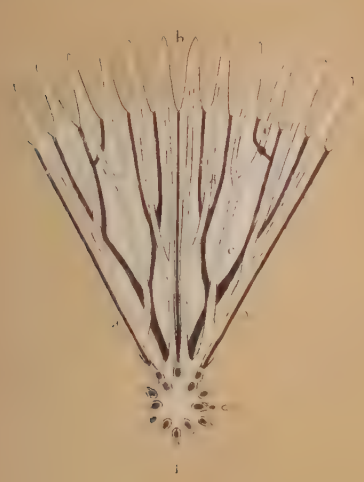

...rixebon ad nat lith Hanhart imp

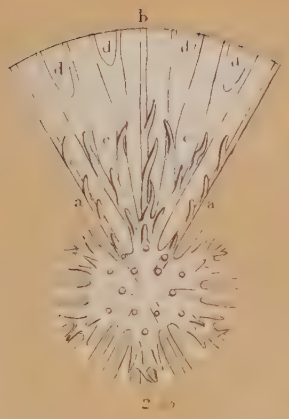
LEPTOPENUS.

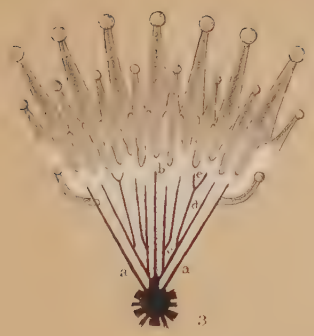
Parkins del et lith

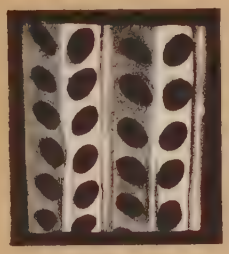
Hanhart imp

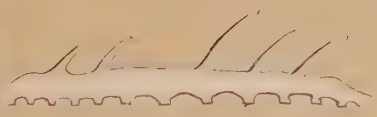
1-7 FLABELLUM. 8 THECOPSAMMIA. 9-12 BALANOPHYLLIA

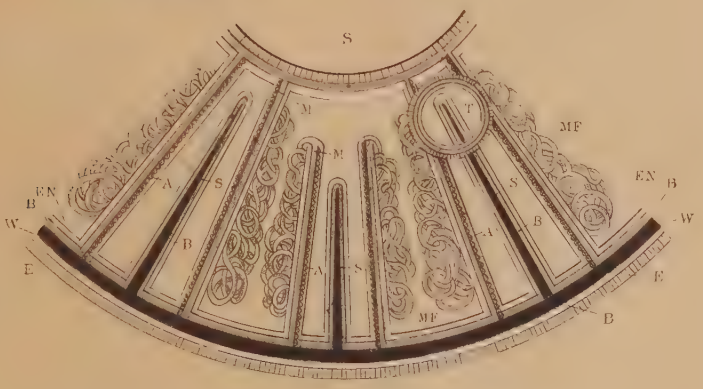


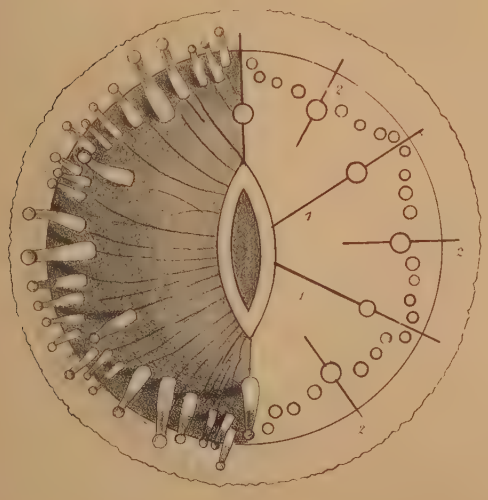


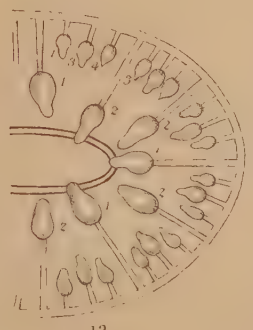












H.N.Moseley del

Hanhart lith

LEPTOPENUS, STEPHANOPHYLLIA, FLABELLUM.

THE

# VOYAGE OF H.M.S. CHALLENGER.

## ZOOLOGY.

REPORT on the Birds collected during the Voyage of H.M.S. Challenger in the years 1873-1876. By Philip Lutley Sclater, M.A., Ph.D., F.R.S., F.L.S., F.G.S., F.R.G.S., Secretary to the Zoological Society of London.

### INTRODUCTION.

On the return of the Challenger, I had great pleasure in acceding to the request of Sir C. Wyville Thomson to undertake the examination of the skins of the birds collected during the voyage. The whole collection embraced about 900 specimens in skins, besides which there was a considerable series of sea-birds in salt and spirit, useful principally for anatomical purposes, and a collection of eggs, mostly of oceanic species.

The collection was formed under the superintendence of Mr John Murray, one of the naturalists of the Expedition, and the skins were chiefly prepared by Mr Frederick Pearcey, who accompanied the vessel as taxidermist. They are, nearly without exception, in an excellent state of preservation.

Mr Murray has kindly placed at my disposal his ornithological note-book, which contains the history of every individual specimen, and many other particulars which add greatly to the value of the collection. He has, besides, furnished me with further notes for the present Report. The particulars and remarks thus obtained are designated by being included in brackets.

It will be recollected that the main object of the Challenger Expedition was the exploration of the depths of the ocean, and that the collecting of birds, and especially

of land-birds, formed but a very subordinate part of the original plan. Ornithologists must therefore not be surprised that so small a collection was made during a three years' voyage, but should rather be very thankful to Sir C. Wyville Thomson and his coadjutors for having devoted so much extra attention to a branch of science in which investigations were not required of them.

The only efficient way of working out a large general collection in the present day, even in the limited class of birds, being to obtain the assistance of specialists in different branches, I proceeded to divide the collection, after a preliminary examination, into the following categories :—

*A.* Terrestrial Birds.

| | |
|---|---|
| 1. Atlantic Islands, *i.e.*, Tristan da Cunha and Inaccessible, | 12 |
| 2. Kerguelen Island, | 16 |
| 3. Cape York, Australia, | 60 |
| 4. Arrou Islands, | 62 |
| 5. Moluccas, *i.e.*, Banda, Ternate, Amboyna, and Ki, | 70 |
| 6. Philippines, | 95 |
| 7. Admiralty Islands, | 56 |
| 8. South Pacific Islands, *i.e.*, Friendly Islands, Fijis, New Hebrides, and Tahiti, | 135 |
| 9. Sandwich Islands, | 24 |
| 10. Antarctic America, Juan Fernandez, and Falklands, | 149 |
| 11. Miscellaneous, | 26 |

*B.* Oceanic Birds.

| | |
|---|---|
| 12. Laridæ, | 47 |
| 13. Procellariidæ, | 80 |
| 14. Steganopodes, | 33 |
| 15. Spheniscidæ, | 38 |
| | 903 |

To aid me in my labours I was then fortunate enough to obtain the assistance of the late Marquis of Tweeddale, President of the Zoological Society of London, and one of the

leading authorities on Indian ornithology, of Dr Otto Finsch of Bremen, of Professor T. Salvadori of Turin, of Mr Howard Saunders—unrivalled in his knowledge of the Laridæ—and of Mr W. A. Forbes, F.Z.S. With the co-operation of these gentlemen, and of my constant friend and fellow-worker, Mr Osbert Salvin, I proceeded to work upon the collection.

Preliminary reports on the results of our labours were read before the Zoological Society of London, and published from time to time, with the permission of the Treasury, in the Society's "Proceedings." The present Report consists mainly of a reprint of these preliminary reports, with such additions and alterations as have been rendered necessary by the progress of science since their publication.

The thirty coloured plates, which illustrate the most remarkable species obtained during the Expedition, have in every case been taken from specimens belonging to the Challenger series.

According to the arrangements made by Sir Wyville Thomson with H.M. Government, the whole of the collection of bird-skins and eggs, with the exception of the few duplicates, will be deposited in the British Museum, as soon as the present Report is completed.

P. L. S.

# CONTENTS.


PAGE

I. On the Birds collected in the Philippine Islands. By Arthur, Marquis of Tweeddale, F.R.S., President of the Zoological Society of London, . . . . . 5

II. On the Birds collected in the Admiralty Islands. By P. L. Sclater, M.A., Ph.D., F.R.S., . 25

III. On the Birds collected in Tongatabu, the Fiji Islands, Api (New Hebrides), and Tahiti. By Dr O. Finsch, C.M.Z.S., . . . . . 34

IV. On the Birds collected in Ternate, Amboyna, Banda, the Ki Islands, and the Arrou Islands. By T. Salvadori, C.M.Z.S., . . . . . 58

V. On the Birds collected at Cape York, Australia, and on the Neighbouring Islands (Raine, Wednesday, and Booby Islands). By W. A. Forbes, F.Z.S., . . . . . 84

VI. On the Birds collected in the Sandwich Islands. By P. L. Sclater, M.A., Ph.D., F.R.S., . 93

VII. On the Birds collected in Antarctic America. By P. L. Sclater, M.A., Ph.D., F.R.S., and Osbert Salvin, M.A., F.R.S., . . . . . 99

VIII. On the Birds collected on the Atlantic Islands and Kerguelen Island, and on the Miscellaneous Collections. By P. L. Sclater, M.A., F.R.S., . . . . . 110

IX. On the Steganopodes and Impennes collected during the Expedition. By P. L. Sclater, Ph.D., F.R.S., and Osbert Salvin, M.A., F.R.S., . . . . . 117

X. On the Laridæ collected during the Expedition. By Howard Saunders, F.R.S., F.L.S., . 133

XI. On the Procellariidæ collected during the Expedition. By Osbert Salvin, M.A., F.R.S., &c., . 140


# APPENDIX.


I. List of the Eggs collected during the Expedition. By P. L. Sclater, M.A., F.R.S., . 150

II. Note on the Gizzard and other Organs of *Carpophaga latrans*. By A. H. Garrod, M.A., F.R.S., Prosector to the Zoological Society of London, . . . . . 152

Explanation of the Plates, . . . . . 155

Index, . . . . . 159

# I.—*On the Birds collected in the Philippine Islands.* By Arthur, Marquis of Tweeddale, F.R.S., *President of the Zoological Society of London.*

(Plates I. to VI.)

(Reprinted from the Proceedings of the Zoological Society of London for 1877.
With corrections and additions by P. L. Sclater, F.R.S.)

[The best, in fact the only, general account of the Ornithology of the Philippine Islands is that given by the much lamented author of the present Report in the ninth volume of the Zoological Society's Transactions.[1] After the preparation of this Memoir, the late Lord Tweeddale having become greatly interested in the avi-fauna of this Archipelago, arranged with a well-known collector, Mr A. H. Everett, to visit the different islands and to make collections of birds for him. The results of this expedition were given in twelve papers published in the Zoological Society's Proceedings for 1877 and 1878.[2]

Mr Sharpe's important memoir on the birds collected by Professor Steere in the Philippines,[3] which was issued just after Lord Tweeddale's report on the Birds of the Challenger Expedition, should also be consulted on this subject. At the time of his death the late Lord Tweeddale was in communication with me upon the subject of a general article to embrace the results arrived at in these different contributions.—P. L. S.]

The Challenger Expedition, during its stay in the Philippine Archipelago, visited six islands, viz., Panay (Ilo-ilo), Luzon (Manila), Zebu, Camiguin, Malanipa, and Mindanao (Samboangan and Pasamanca). It is not on record that two of these islands, Camiguin and Malanipa, had ever been previously visited by any ornithological collector; while from Mindanao only some nineteen species of birds were known. Dr Steere, at about the time the Challenger was near Mindanao, collected many additional species of birds on that island, as he had also done in the islands of Zebu and Panay; and as the results of his researches have already been made known by Mr Bowdler Sharpe,[4] some of the discoveries made by the Challenger naturalists have been anticipated. In order that the exact

[1] A List of the Birds known to inhabit the Philippine Archipelago, by Arthur, Viscount Walden, F.R.S., Trans. Zool. Soc., vol. ix. p. 195.

[2] Contributions to the Ornithology of the Philippines, No. I., Proc. Zool. Soc., 1877, p. 686; No. II., *ibid.*, p. 755; No. III., *ibid.*, p. 816; No. IV., *ibid.*, 1878, p. 106; No. V., *ibid.*, p. 280; No. VI., *ibid.*, p. 339; No. VII., *ibid.*, p. 379; No. VIII., *ibid.*, p. 420; No. IX., *ibid.*, p. 611; No. X., *ibid.*, p. 708; No. XI., *ibid.*, p. 939; No. XII., *ibid.*, 1879, p. 68.

[3] On the Birds collected by Professor J. B. Steere in the Philippine Archipelago, Trans. Linn. Soc., ser. 2, Zool., vol. i., part vi. (1877).

[4] Trans. Linn. Soc., ser. 2, Zool., vol. i. I am much indebted to Mr Sharpe for his courtesy in permitting me to peruse his paper while it was passing through the press. Without this assistance it would have been impossible for me to have completed this report at so early a date.

course taken by the Challenger may be recorded, with the dates on which the Expedition arrived at, and departed from, the different islands, I transcribe the following extracts from Mr J. Murray's ornithological note-book, adding to each extract the names of the birds, as I have determined them :—

"The ship arrived off Samboangan on the evening of the 23d October 1874, and sailed again on the morning of the 26th. The species obtained were—

[*Munia jagori.*
*Charadrius fulvus.*
*Corvus philippinus.*
*Ixus goiavier.*
*Sterna bergii.*]

"The ship arrived at Ilo-ilo on the 28th [October 1874], at 5 P.M. On the 30th the following birds were shot. These are all from the island opposite the town :—

[*Osmotreron axillaris.*
*Broderipus acrorhynchus.*
*Loriculus panayensis.*
*Entomobia gularis.*
*Sauropatis chloris.*
*Pelargopsis gigantea.*
*Centrococcyx viridis.*
*Corvus philippinus.*
*Corydalla lugubris.*
*Lalage dominica.*
*Orthotomus castaneiceps.*
*Arachnechthra jugularis.*]

"The ship arrived at Manila on the 11th January 1875, and left there on the 14th January. The following two birds were shot from the ship during the stay :—

[*Larus ridibundus.*
*Hydrochelidon hybrida.*]

"The ship arrived at Zebu on the 18th January 1875, and left on the 24th. During the stay Pearcey and some of the officers shot the following birds :—

[*Broderipus acrorhynchus.*
*Artamus leucorhynus.*
*Sauropatis chloris.*
*Haliastur intermedius.*
*Numenius phæopus.*
*Demiegretta sacra.*
*Hypsipetis philippinensis.*
*Lanius lucionensis.*
*Merops philippinus.*]

"Parties landed on the volcanic island of Camiguin on the 26th January 1875 for a few hours in the afternoon, and the following birds were shot :—

[*Corvus philippinus.*
*Calornis panayensis.*
*Sauropatis chloris.*
*Arachnechthra jugularis.*
*Tringoides hypoleucos.*]

"On the 30th January a party landed, early in the morning, on the island of Malanipa, Basilan Straits, near Samboangan, and returned to the ship at 2 P.M. The following birds were shot :—

[*Eudynamis mindanensis.*
*Myristicivora bicolor.*
*Haliastur intermedius.*
*Tanygnathus lucionensis.*
*Pelargopsis gigantea.*
*Numenius phæopus.*
*Nectarophila juliæ.*
*Totanus incanus.*
*Hypothymis azurea.*]

"On the 1st February 1875 a party of four officers and three men left the ship, with tent, &c., and went up to the high land beyond Samboangan. The tent was pitched in a valley called Pasananca, at a distance from Samboangan of some seven miles.

"The cliffs on either side of the valley were composed of a volcanic conglomerate, and the rocks in the bed of the stream were fragments of this conglomerate and of greenstone.

"The sides and centre of the valley were covered with luxuriant vegetation—palms, creepers, ferns, and fine large timber.

"The tent and baggage had to be transported on horseback. The party remained at the spot the 2d, 3d, and 4th, and returned to the ship on the 5th, at about mid-day. The following birds were obtained by the party, and were skinned by Pearcey at the tent :—

[*Buceros mindanensis.*
*Broderipus acrorhynchus.*
*Merops philippinus.*
„ *bicolor.*
*Entomobia gularis.*
*Pelargopsis gigantea.*
*Dicrurus striatus.*
*Hypsipetis rufigularis.*
*Ixus goiavier.*
*Phabotreron brevirostris.*
*Batrachostomus septimus.*
*Harpactes ardens.*
*Erythropitta erythrogastra.*
*Chrysocolaptes lucidus.*
*Prioniturus discurus.*
*Calobates melanope.*
*Dicæum mindanense.*
*Haliastur intermedius.*
*Tringoides hypoleucos.*
*Eurystomus orientalis.*
*Rhynchæa capensis.*
*Gallinago stenura.*]"

Thus it will be seen that twelve species were obtained in Panay, two in Luzon, nine in Zebu, five in Camiguin, nine in Malanipa, and twenty-four in Mindanao.

Mr Murray's field-notes will be found added under the head of each species, included in brackets, together with the collection-numbers.

The ornithological results of the Challenger's short stay in the Philippine Archipelago may be summarised as follows :—

Specimens obtained, 98; species obtained, 49; new species obtained, 7, namely :—

*Loriculus panayensis.*
*Batrachostomus septimus.*
*Dicrurus striatus.*
*Nectarophila juliæ.*
*Buceros mindanensis.*
*Dicæum mindanense.*
*Phabotreron brevirostris.*

Genera added, 2 :—

*Batrachostomus.* | *Demiegretta.*

Habitat determined within the Archipelago, 1 :—

*Rhynchæa capensis.*

Habitat corrected, 1 :—

*Chrysocolaptes lucidus.*

Known species added to the Philippine fauna, 4 :—

*Totanus incanus.*
*Gallinago stenura.*
*Demiegretta sacra.*
*Sterna bergii.*

Range of known Philippine species extended within the Archipelago, 23 :—

| | Malaulpa. | Mindanao. | Camiguin. | Panay. | Zebu. |
|---|---|---|---|---|---|
| *Tanygnathus lucionensis* | * | | | | |
| *Haliastur intermedius* | * | * | ..... | ..... | * * |
| *Merops philippinus* | ..... | ..... | ..... | ..... | * |
| *Pelargopsis gigantea* | * | | | | |
| *Entomobia gularis* | ..... | * | | | |
| *Sauropatis chloris* | ..... | ..... | * | * | |
| *Eudynamis mindanensis* | * | | | | |
| *Artamus leucorhynchus* | ..... | ..... | ..... | ..... | * |
| *Hypothemis azurea* | * | | | | |
| *Broderipus acrorhynchus* | ..... | ..... | ..... | * | |
| *Ixus goiavier* | ..... | * | | | |
| *Hypsipetes rufigularis* | ..... | * | | | |
| *Calobates melanope* | ..... | * | | | |
| *Corydalla lugubris* | ..... | ..... | ..... | * | |
| *Arachnechthra jugularis* | ..... | ..... | * | | |
| *Corvus philippinus* | ..... | * | * | * | |
| *Calornis panayensis* | ..... | ..... | * | | |
| *Munia jagori* | ..... | * | | | |
| *Osmotreron axillaris* | ..... | ..... | ..... | * | |
| *Myristicivora bicolor* | * | | | | |
| *Charadrius fulvus* | ..... | * | | | |
| *Numenius phæopus* | * | | | | |
| *Tringoides hypoleucos* | ..... | * | * | | |
| | 7 | 9 | 5 | 5 | 3 |

1. *Prioniturus discurus*, Vieill.

*Psittacus discurus*, Vieill., Gal. des Ois., vol. i. p. 7, t. lxxvi., Mindanao, 1825.
*Prioniturus discurus*, Walden, Trans. Zool. Soc., vol. ix. p. 132; Proc. Zool. Soc., 1877, pp. 538, 688, 817, 756; 1878, pp. 379, 937; 1879, p. 68.

[No. 431, ♂. Pasananca. Eyes grey. It frequents the banana-trees, and feeds on their fruit, of which the stomach was full.]

Luzon and Guimaras individuals do not differ from this typical example.

2. *Tanygnathus lucionensis*, Linn.

*Psittacus lucionensis*, Linn., Syst. Nat., vol. i. p. 146, No. 31, 1766.
*Tanygnathus lucionensis*, Walden, Trans. Zool. Soc., vol. ix. p. 133; Proc. Zool. Soc., 1877, p. 538; 1878, pp. 281, 340, 612, 937; 1879, p. 68.

[No. 377, ♂. Malanipa. Eyes white.]

Does not differ from typical examples. The locality is new.

3. *Loriculus panayensis*, Tweedd. (Pl. I. ♂ et ♀).

*Loriculus regulus*, Souancé: Sharpe, Trans. Linn. Soc., ser. 2, Zool., vol. i. p. 313.
*Loriculus panayensis*, Walden, Proc. Zool. Soc., 1877, p. 538.

[No. 348, ♂. } Ilo-ilo. Eyes brown; feet orange; bill red. Stomach had seeds.]
No. 349, ♀. }

♂. Grass-green, below lighter. Forehead and sinciput bright blood-red; vertex and occiput green, washed with golden yellow; a narrow band, separating the red sinciput from the golden vertex, yellow. A golden mark across the nape. Uropygium and upper tail-coverts dark scarlet. A decided line round the mouth and base of mandible, verditer-blue. Breast yellowish green. Outer webs of quills dark green, inner black, above; quills underneath black, most of the inner webs of primaries being blue, and all of the inner webs of the remaining quills. Rectrices dark green, blue underneath. Short under wing coverts dark green, longer blue. Bill coral-red.

♀. Like the male, but differs in having the vertex and occiput green, and no blue round the mouth.

| | Wing. | Tail. | Tarsus. | Bill from nostril. |
|---|---|---|---|---|
| | inches. | inches. | inches. | inches. |
| ♂, . . . . | 3·62 | 2·12 | 0·37 | 0·43 |
| ♀, . . . . | 3·56 | 2·00 | 0·37 | 0·43 |

This species above closely resembles *Loriculus regulus, ex* Negros, but differs in

wanting the red pectoral patch and in having blue feathers at the base of the mandible. The female only differs from that of *Loriculus regulus* in having no blue feathers round the mouth, though a few are present at the top of the throat.

Dr O. Finsch has remarked (Ibis, 1874, p. 208) that *Loriculus chrysonotus* has no orange mark on the nape; but I find this mark very conspicuous in a specimen belonging to my series of the species, *ex* Zebu.

4. *Haliastur intermedius*, Blyth.

*Haliastur intermedius*, Blyth, Ibis, 1865, p. 28; Walden, Trans. Zool. Soc., vol. ix. p. 142; Proc. Zool. Soc., 1877, pp. 539, 689, 757, 821; 1878, pp. 282, 340, 709, 937.

[No. 373, ♂. Zebu. Eyes brown. Shot from the ship at the anchorage at Zebu.
No. 374, ♂. Zebu. Eyes brown. Stomach contained offal.
No. 388, ♂. Malanipa. Eyes yellow.
No. 434, ♂. Pasananca. Eyes brown.]
Not previously recorded from these three localities.

5. *Chrysocolaptes lucidus*, Scop.

*Picus lucidus*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 89, No. 51, 1786.
*Chryscolaptes lucidus*, Walden, Trans. Zool. Soc., vol. ix. p. 147, Proc. Zool. Soc., 1877, pp. 593, 822; 1878, pp. 379, 942.

[No. 430, ♂. Pasananca. Eyes red. These birds were seen in considerable numbers, and frequently heard.]

Unless *Chrysocolaptes maculiceps*, Sharpe (Trans. Linn. Soc., ser. 2, Zool., vol. i. p. 314), belongs to this species, this Mindanao specimen appears to be the first that has been brought to Europe since Sonnerat's day; for now that I have the opportunity of comparing it with *Chrysocolaptes hæmatribon*, I doubt the correctness of the identification of Jagor's young bird *ex* Luzon by Dr v. Martens (J. f. Orn., 1866, p. 20, No. 110), and for the reasons that, first, *Chrysocolaptes lucidus* is a representative form of *Chrysocolaptes hæmatribon*, and secondly, if a Luzon bird, it would have been found by some one of the collectors who have well worked the vicinity of Manila since Sonnerat collected in its neighbourhood. If this be so, Sonnerat must have obtained his own type specimen and that of Buffon, not in Luzon, but at or near Samboangan, where the naturalists of the Challenger procured this one. The species is accurately described, from Sonnerat's type-specimen in the Paris Museum, by Malherbe (Monogr. Picidæ, vol. ii. p. 85), although his figure (*op. cit.*, t. xvi., fig. 3) shows too little carmine and too much golden on the wings, and is thus inconsistent with his own description.

Mr Sharpe's type-specimen has unfortunately gone to America. It was obtained in Basilan by Mr Steere, and, from the description and specific title, seems to have been a

male in imperfect plumage. It has the concealed white spots on the webs of the outer rectrices, which constitute one of the peculiar characters of *Chrysocolaptes lucidus*. Sonnerat, in his plate (Voy. N. Guin., pl. xxxvii.), exhibits these spots on all the rectrices; but this is an error. If not the same as *Chrysocolaptes lucidus*, *Chrysocolaptes maculiceps* is a very closely allied representative form. *Chrysocolaptes lucidus*, together with *Chrysocolaptes xanthocephalus* and *Chrysocolaptes hæmatribon*, form a small subgroup, of which the only other member occurs in Ceylon (*Chrysocolaptes stricklandi*); but *Chrysocolaptes lucidus*, with its partly golden wings, seems to be a connecting link with the typical species of *Chrysocolaptes*.

6. *Harpactes ardens*, Temm.

*Trogon ardens*, Temm., Pl. Col. 404, ♀, Mindanao, 1826.
*Harpactes ardens*, Walden, Trans. Zool. Soc., vol. ix. p. 149; Proc. Zool. Soc., 1877, p. 540; 1878, pp. 107, 943.

[No. 428, ♂. Pasananca. Legs bluish; bill orange; eyes hazel. Stomach had insects. This species was only seen in the thickest part of the woods. One sitting on a branch allowed me to approach and almost touch it with my gun.]

Luzon males do not differ from this typical example.

7. *Merops philippinus*, Linn.

*Merops philippinus*, Linn., Syst. Nat., ed. 13 (Vindob.), vol. i. p. 183, No. 5, 1767; Walden, Trans. Zool. Soc., vol. ix. p. 149; Proc. Zool. Soc., 1877, pp. 540, 690; 1878, pp. 107, 282, 340, 709.

[No. 380, ♂. Zebu. Eyes red.
No. 412, ♂. } Pasananca. Bill and feet black; eyes red. Frequents open spaces.]
No. 413, ♂. }

These examples in no respect differ from Luzon and Negros individuals, or, indeed, from examples from any part of the Indian region. Not hitherto recorded from Zebu.

8. *Merops bicolor*, Bodd.

*Merops bicolor*, Bodd., Tab. Pl. Enl., p. 15, No. 252, 1783; Walden, Trans. Zool. Soc., vol. ix. p. 150, t. xxvi. fig. 1; Proc. Zool. Soc., 1877, pp. 540, 690, 757, 822; 1878, pp. 282, 340, 937.

[No. 414, ♂. Pasananca. Eyes red; feet violet (slightly). Shot in open ground. Both the above species of Bee-eaters were common about the camps, and seemed to associate much together and to have the same habits.]

Not to be distinguished from Luzon and Negros individuals.

9. *Eurystomus orientalis*, Linn.

*Coracias orientalis*, Linn. Syst. Nat., vol. i. p. 154, No. 4, 1766.
*Eurystomus orientalis*, Walden, Trans. Zool. Soc., vol. ix. p. 152; Proc. Zool. Soc., 1877, pp. 540, 690, 757, 822; 1878, pp. 108, 282, 341, 613; 1879, p. 69.

[No. 426, ♂. Pasananca. Feet and bill red; tip of mandible black.]

Agrees with Ceylon examples, as well as with those from localities already mentioned (*ll.cc.*).

10. *Pelargopsis gigantea*, Walden.

*Pelargopsis gigantea*, Walden, Ann. and Mag. Nat. Hist., vol. xiii. p. 123, ser. 4, 1874; Proc. Zool. Soc., 1877, pp. 541, 822; 1878, pp. 108, 341, 943; 1879, p. 69.

[No. 352, ♂. Ilo-ilo. Eyes black; feet red; bill red, tipped with black. Stomach had fish.

No. 400, ♀. Malanipa. Eyes black.

No. 417, ♂. Pasananca. Eyes black; bill and legs red. Had in the stomach an eel about 6 inches in length.]

The example from Malanipa (No. 400), from which island the species has not been hitherto recorded, and the one from Pasananca (No. 417) are somewhat smaller than the type specimen of *Pelargopsis gigantea*, but in other respects do not differ specifically. In colouring, the Malanipa bird is hardly distinguishable from the type; but the Mindanao example has the wings, scapulars, and interscapulars of a much purer blue. The Panay bird (No. 352) has the same parts of a still purer blue (as opposed to greenish blue), and all the plumage, including the head, which is more or less white in the type, is creamy buff, most intense on the flanks, abdomen, and under tail-coverts.

Our acquaintance with the mutations of colouring and what they denote in many of the so-called species of this group is yet very limited; and I prefer to retain for the present the Ilo-ilo bird under the title above given.

The specimens measure as follows:—

| | Wing. | Tail. | Bill from forehead. | Bill from gape. |
|---|---|---|---|---|
| | inches. | inches. | inches. | inches. |
| Type, *ex* Sulu, near Borneo, . . | 6·56 | 4·25 | 3·50 | 4·00 |
| ♂, *ex* Pasananca, . . . . | 6·00 | 4·00 | 3·25 | 3·56 |
| ♀, *ex* Malanipa, . . . . . | 6·06 | 4·00 | 3·25 | 3·56 |
| ♂, *ex* Ilo-ilo, . . . . . | 6·00 | 4·00 | 3·12 | 3·62 |

11. *Entomobia gularis*, Kuhl.

*Alcedo gularis*, Kuhl, Buff. and D'Auben., Fig. Av. Col. Nom. Syst., p. 4, 1820; Proc. Zool. Soc., 1877, pp. 541, 822; 1878, pp. 108, 341, 943.
*Entomobia gularis*, Walden, Trans Zool. Soc., vol. ix. p. 154.

[No. 350, ♂. } Ilo-ilo. Eyes black; legs and bill dark red. Stomach had insects.
No. 351, ♂. }
No. 415, ♂. } Pasananca. Eyes black; feet and bill red.]
No. 416, ♀. }

Luzon, Negros, and Zebu individuals agree well with these Panay and Mindanao examples. The last island is a new locality for the species.

12. *Sauropatis chloris*, Bodd.

*Alcedo chloris*, Bodd., Tabl. Pl. Enl., p. 49, 1783; Proc. Zool. Soc., 1877, pp. 541, 690, 758 823; 1878, pp. 108, 282, 341, 709, 937; 1879, p. 69.
*Sauropatis chloris*, Walden, Trans. Zool. Soc., vol. ix. p. 155.

[No. 353, ♂. } Ilo-ilo. Eyes black. Stomach had insects.
No. 354, ♀. }
No. 371, ♂. } Zebu. Eyes black.
No. 372, ♀. }
No. 387, ♂. } Camiguin.]
No. 388, ♀. }

A Zebu male (No. 371) has the pectoral and lateral feathers conspicuously margined with greyish brown; and this is observed in a less degree in a female (No. 354) from Ilo-ilo. Panay and Camiguin are new localities.

13. *Batrachostomus septimus*, Tweedd. (Pl. II.).

*Batrachostomus septimus*, Tweeddale, Proc. Zool. Soc., 1877, p. 542; 1878, p. 944.

[No. 427, ♀. Pasananca. Eyes brown. Stomach had insects.]

*Rufous phase.*—Head, interscapulars, and elongated occipital crest rufous brown, most of the feathers with a pair of pale rufous spots on either web, and defined by a narrow brown transverse bar. Elongated auriculars barred alternately with brown and rufous. A patch before the eye albescent rufous. A conspicuous nuchal collar formed by a series of very broad feathers brown at the base, then an irregular subdued brown transverse narrow band, followed by a pale rufous band, then another narrow zig-zag brown band, which is succeeded by another pale rufous band, bounded below by a broad transverse dark brown almost black band, which is succeeded by a still broader white band, bordered again with black; the white band is separated from the black above and below by a rusty margin. Feathers of the back, rump, and upper tail-coverts rufous,

with irregular transverse brown markings, and in some with brown centres. Scapulars tawny rufous and pure rufous, irregularly marked with brown zig-zags, several with a subterminal black mark and a terminal tawny rufous spot. Wing-coverts chestnut, with brown vermiculations; the greater coverts with large, pure white, ovoid terminal drops, mostly situated on the outer webs, and bounded above and on the inner margins with black. Quills brown on the inner webs, pale rufous on the outer, with obscure pale brown marks. Tertiaries pale rufous on the outer webs, much indented with the brown of the inner webs. Innermost tertiaries pale rufous on both webs, transversely marked with cloudy brown. Tips of several of the inner webs of the quills pale rufous. Rectrices pale rufous, traversed by several bars of rufous brown, each bar being bounded above and below by a brown line. Penultimate pair of rectrices with rufous spots, rather than bands. Exterior short pair with almost pure white spots on the inner web. Chin and throat dingy rufous, intersected by brown zig-zag lines. A gular collar, formed of broad feathers with a broad subterminal pure white band, bounded below and above by a narrow dark brown band. Feathers of the upper breast dingy rufous freckled brown, pale tawny rufous at the base, with brown transverse lines and traces of white spots on the margins of some of the webs. Concealed lower breast and flank-plumes mostly pure white, with dark grey markings near the base, and terminated with rufous freckled with brown. Abdominal feathers pale albescent rufous, striated with brown, and some marked with pure white. Feathers of the ventral region isabelline white, with small obscure pale tawny rufous margins. Under tail-coverts isabelline, the longer with subterminal marks of brown and rusty. Under wing-coverts greyish white, banded with rufous brown. Thigh-coverts dark rufous brown. Stiff nasal plumes rufous, tipped brown. Wing 6 inches, tail 4·5, tarsus 0·68, middle toe 0·75, bill (from forehead) 1·12, width of gape 1·37. The tarsus is feathered anteriorly for about one-fourth of its length; the bill is massive.

14. *Eudynamis mindanensis*, Linn.

*Cuculus mindanensis*, Linn. Syst. Nat., vol. i. p. 169, No. 3, 1766.
*Eudynamis mindanensis*, Walden, Trans. Zool. Soc., vol. ix. p. 162; Proc. Zool. Soc., 1877, pp. 543, 691, 823; 1878, p. 946; 1879, p. 70.

[No. 392, ♂.
No. 393, ♂. } Malanipa. Eyes red.]
No. 394, ♀.

Malanipa is a new locality for this species; but, from its proximity to Mindanao, the examples may be considered typical.

The two males are in full black plumage, with a green gloss. They have, however, a shorter wing than Guimaras examples, the only other Philippine examples I have been

able to compare them with. The female is without a tail; and in the absence of any other Philippine individuals of that sex I can make no satisfactory comparisons.

| | Wing. | Tail. | Bill from nostril. | Tarsus. | Middle toe. |
|---|---|---|---|---|---|
| | inches. | inches. | inches. | inches. | inches. |
| No. 392, ♂, . . | 7·38 | 7·62 | 0·75 | 1·25 | 1·12 |
| No. 393, ♂, . . | 7·38 | 8·00 | 0·75 | 1·25 | 1·12 |
| No. 394, ♀, . . | 6·75 | ... | 0·75 | 1·25 | 1·12 |

No. 392 has a pure white primary wing-covert.
Mindanao individuals remain a desideratum.

15. *Centrococcyx viridis*, Scop.

*Cuculus viridis*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 89, No. 47, 1786.
*Centrococcyx viridis*, Walden, Trans. Zool. Soc., vol. ix. p. 163; Proc. Zool. Soc., 1877, pp. 543, 691, 758, 823; 1878, pp. 283, 341, 709, 946.

[No. 355, ♀. Ilo-ilo. Eyes red. Stomach had insects.]

A young bird, with many new feathers coming in. Old feathers of the body and tail brown. Examples from Luzon, Negros, Zebu, and Guimaras (*mus. nostr.*) do not differ from this typical specimen. There is no record of a Panay example having reached Europe since Sonnerat's time.

16. *Buceros mindanensis*, Tweedd. (Pl. III.).

*Buceros mindanensis*, Tweeddale, Proc. Zool. Soc., 1877, p. 543; 1878, pp. 278, 446; 1879, p. 70.

[No. 407, ♂. } Pasananca. Eyes yellowish grey; legs, base and knob of bill red; tips
No. 408, ♀. } of upper and lower mandible white.

No. 409, ♀. Pasananca. Bill nearly uniform black, tinged with red; eyes blue. On the whole, appears a much younger bird.

The stomachs of all contained seeds and fruit, and grubs, centipedes, grasshoppers, &c. These birds make a loud sound, like a crow somewhat, and frequent the highest trees. Several times in the early morning we came upon them on the ground under the trees, tearing at the roots of the trees and old logs. They were evidently in search of grubs, caterpillars, &c., as I found them in their stomachs.]

These examples belong to a representative form of *Buceros hydrocorax* of Luzon. They differ from that species in having a corrugated plate on the basal part of the sides of the mandible, in the casque being narrower, in the general dimensions being less, and in the anterior three-fourths of the mandible and about the anterior half of the maxilla

being white, and the rufous of the thigh-coverts, of the head, nape, and throat, being much darker.

♂ adult. Casque, posterior half of maxilla, rami of mandible, and posterior part of gonys blood-red. Corrugated lateral plates of mandible darker blood-red. Remainder of bill pale straw-white. Feathers surrounding the eye and clothing the base of mandible, chin, and gullet black. Head, nape, and upper part of breast, lower throat, and thigh-coverts deep rufous maroon. Upper throat tawny. Breast black. Interscapulars and wing-coverts ruddy brown. Upper tail-coverts ferruginous. Under tail-coverts and vent light dingy rust-colour. Quills black; secondaries narrowly margined externally with ferruginous, and tipped with rusty white. Rectrices ruddy ochre.

♀ adult. Like male, as is the case in *Buceros hydrocorax*.

♀ juv. Differs chiefly in the casque not being so fully developed anteriorly and not overhanging the true culmen, and in its culmen being dingy brown and grey-brown, with indications of red on the casque and at base of mandible. The grooved lateral plates have not appeared. The tarsus and feet in all appear to have been blood-red.

The figure (Pl. III.) is taken from the male specimen, No. 407.

In the true *Buceros hydrocorax* slight indications of grooves are perceptible on the walls of the base of the mandible; but they are cut in the substance of the mandible, and do not form part of an adhering plate.

| | Wing. | Tail. | Tarsus. | Middle toe. | Bill from gape. | Casque. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Length. | Breadth. |
| | inches. | inches. | inches. | inches. | inches. | inches. | inches. |
| *Buceros hydrocorax* ♂, . . | 16·00 | 14·25 | 3·00 | 2·00 | 7·00 | 5·75 | 2·30 |
| „ *mindanensis* ♂, . | 15·50 | 14·00 | 3·00 | 1·60 | 6·62 | 6·00 | 2·00 |
| „ „ ♀, . | 14·25 | 12·50 | 2·75 | 1·75 | 6·25 | 5·75 | 1·87 |
| „ „ ♀, juv. . | 14·25 | 13·50 | 3·00 | 1·75 | 5·62 | 4·50 | 1·50 |

17. *Lanius lucionensis*, Linn.

*Lanius lucionensis*, Linn., S. N., vol. i. p. 135, No. 10, 1766; Walden, Trans. Zool. Soc., vol. ix. p. 171, t. xxix. fig. 1; Proc. Zool. Soc., 1877, pp. 544, 692, 759; 1878, pp. 342, 380, 614, 709, 947.

[No. 379, ♂. Zebu. Eyes hazel.]

18. *Artamus leucorhynchus*, Linn.

*Lanius leucorhynchus*, Linn., Mantissa Plant, p. 524, "Imarishia," 1771; Walden, Trans. Zool. Soc., vol. ix. p. 174, No. 73; Proc. Zool. Soc., 1877, pp. 544, 692, 759, 826; 1878, pp. 283, 342, 709, 937; 1879, p. 70.

[No. 369, ♂. } Zebu. Eyes brown. Stomach had insects.]
No. 370, ♀. }

Not hitherto recorded from Zebu. Philippine examples of this species exhibit two slightly differing phases of dress, one in which the upper plumage is of a light bluish and cinereous colour, the other where it is more of a smoky brown and bluish ash. This does not seem to depend on sex; for one of these examples (*ex* Zebu, No. 369) is marked ♂, while I possess a Luzon example exactly similar, which Dr Meyer determined to be a ♀. The other Zebu example (No. 370) is marked ♀, and is in the paler bluish-grey attire.

19. *Lalage dominica*, P. L. S. Müll.

*Turdus dominicus*, P. L. S. Müller, Suppl., p. 145, No. 56 (1776).
*Lalage dominica*, Walden, Trans. Zool. Soc., vol. ix. p. 178; Proc. Zool. Soc., 1877, pp. 545, 693, 759, 826; 1878, pp. 108, 284, 342, 709, 948; 1879, p. 70.

[No. 358, ♀. Ilo-ilo. Eyes brown. Stomach had insects.]

20. *Dicrurus striatus*, Tweedd. (Pl. IV.).

*Dicrurus striatus*, Tweeddale, Proc. Zool. Soc., 1877, pp. 545, 826; 1878, pp. 109, 380, 614, 948; 1879, p. 70.

[No. 418, ♂.
No. 419, ♂.
No. 420, ♀.] Pasananca. Eyes red; feet and bills black.

♂, ♀. Nasal and frontal plumes black; vertex and occiput clothed with glistening green-black scale-like feathers; nape, interscapulars, back, uropygium, and under surface velvety bluish black; feathers of lower throat and of breast with glistening, bluish-black, central, narrow lines, imparting a striated appearance; outer edges of the primaries (first and second excepted), exposed surface of all the remaining quills, all the wing-coverts and wing-lining, and the exposed surface of the rectrices glistening green-black; quills above and below and under surface of the webs of the laterals, black; bill and feet black; wing, 5·37 inches; tail, 4·62 inches; tarsus, 0·90; bill from forehead, 1·44.

Of the same type as *Dicrurus balicassius*, with the tail but slightly forked.

The figure (Pl. IV.) is taken from specimen No. 420.

21. *Hypothymis azurea*, Bodd.

*Muscicapa azurea*, Bodd., Tab. Pl. Enl., p. 41 (1783).
*Hypothymis azurea*, Walden, Trans. Zool. Soc., vol. ix. p. 182; Proc. Zool. Soc., 1877, pp. 545, 693, 760, 826; 1878, pp. 109, 284, 615, 948; 1879, p. 70.

[No. 406, ♂. Malanipa. Eyes hazel.]

An additional locality for this species.

22. *Hirundo gutturalis*, Scop.

*Hirundo gutturalis*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 96, No. 115 (1786); Walden, Trans. Zool. Soc., vol. ix. p. 184; Proc. Zool. Soc., 1877, pp. 545, 694.

[No. 362. Caught on board the ship, Oct. 21, 1874, between the Moluccas and the Philippines.]

23. *Oriolus acrorhynchus*, Vigors.

*Oriolus acrorhynchus*, Vigors, Proc. Zool. Soc., 1831, p. 97.
*Broderipus acrorhynchus*, Walden, Trans. Zool. Soc., vol. ix. p. 185; Proc. Zool. Soc., 1877, pp. 545, 694, 760; 1878, pp. 110, 285, 342, 380, 616, 710, 948; 1879, p. 71.

[No. 347, ♂. Ilo-ilo. Eyes white. Stomach had insects, or rather grubs.
No. 365, ♂.
No. 366, ♂.
No. 367, ♀.
No. 368, ♀. } Zebu. Eyes red.]
[No. 410, ♂.
No. 411, ♀. } Pasananca. Eyes red; bill reddish.]

These examples all agree with typical. The difference of the colour of the iris in the Panay bird is curious; from that island the species has not hitherto been recorded.

24. *Pitta erythrogastra*, Temm.

*Pitta erythrogastra*, Temm., Pl. Col., p. 212 (1823).
*Erythropitta erythrogastra*, Walden, Trans. Zool. Soc., vol. ix. p. 187; Proc. Zool. Soc., 1877, pp. 546, 687; 1878, p. 948; 1879, p. 71.

[No. 429, ♂. Pasananca. Eyes black; feet slate-coloured. Insects in the stomach. Only one was noticed. It was hopping about on a slope.]

The exact origin of the original type is not recorded; but I cannot detect any important difference between this Mindanao individual and examples from Luzon.

25. *Ixus goiavier*, Scop.

*Muscicapa goiavier*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 96, No. 109 (1786).
*Ixus goiavier*, Walden, Trans. Zool. Soc., vol. ix. p. 190; Proc. Zool. Soc., 1877, pp. 546, 695, 827; 1878, pp. 110, 285, 342, 710, 949; 1879, p. 72.

[No. 344, ♂. Samboangan. Eyes hazel. Stomach had seeds.
No. 424, ♂.
No. 425, ♂. } Pasananca. Eyes hazel.]

New to Mindanao.

26. *Hypsipetes philippinensis*, Gm.

*Turdus philippinensis*, Gm., S. N., vol. i. p. 814, No. 40 (1788).
*Hypsipetes philippinensis*, Walden, Trans. Zool. Soc., vol. ix. p. 191 ; Proc. Zool. Soc., 1877, pp. 546, 696, 761, 827 ; 1878, pp. 285, 342, 380.

[No. 378, ♂. Zebu. Eyes hazel.]

27. *Hypsipetes rufigularis*, Sharpe.

*Hypsipetes rufigularis*, Sharpe, Trans. Linn. Soc., ser. 2, Zool., vol. i. p. 335 ; Walden, Proc. Zool. Soc., 1877, pp. 546, 827 ; 1878, p. 949 ; 1879, p. 72.

[No. 421, ♂.
No. 422, ♂.
No. 423, ♀.} Pasananca. Eyes brown or hazel.]

The female is somewhat smaller, with a shorter bill. An addition to the fauna of Mindanao.

28. *Orthotomus castaneiceps*, Walden.

*Orthotomus castaneiceps*, Walden, Ann. Nat. Hist., ser. 4, vol. i. p. 252, "Guimaras," 1st Oct. 1872 ; Walden, Trans. Zool. Soc., vol. ix. p. 195 ; Proc. Zool. Soc., 1878, p. 546 ; 1878, p. 286 ; Sharpe, Trans. Linn. Soc., ser. 2, Zool., vol. i. p. 337 ; id. Ibis, 1877, p. 114.

The type was a male ; but this Panay female does not differ.
[No. 359, ♀. Ilo-ilo. Eyes brown. Stomach had insects.]

29. *Calobates melanope*, Pallas.

*Motacilla melanope*, Pallas, Reisen Russischen Reichs, vol. iii. p. 696, No. 16, 1776.
*Calobates melanope*, Walden, Trans. Zool. Soc., vol. ix. p. 196 ; Proc. Zool. Soc., 1877, pp. 546, 697, 761 ; 1878, p. 343.

[No. 432, ♀. Pasananca.]
A female, with greyish brown upper plumage ; tail, 3·56. Recorded for the first time from Mindanao.

30. *Corydalla lugubris*, Walden.

*Corydalla lugubris*, Walden, Trans. Zool. Soc., vol. ix. p. 198, 1875 ; Proc. Zool. Soc , 1877, pp. 547 696, 762, 828 ; 1878, pp. 286, 380, 710.

[No. 357, ♂. Ilo-ilo. Eyes hazel. Stomach had seeds.]
Panay is an additional locality.
This example differs from the type in having the tertiaries and most of the wing-coverts broadly margined externally with pale rufous, not albescent. The pectoral feathers are tinged with pale rufous ; and the brown central streaks are much broader than in the type. The flanks are washed with pale rufous.

31. *Dicæum mindanense*, Tweedd. (Pl. V. fig. 1).

*Dicæum mindanense*, Tweeddale, Proc. Zool. Soc., 1877, p. 547.

[No. 433, ♂. Pasananca.]

♂. Above, cheeks and ear-coverts fuliginous olive-green. Below greyish white, most grey on the breast; quills dark brown, narrowly margined with olive-green on outer webs; tertiaries with the olive-green margins broader; rectrices dark brown, faintly edged with olive; axillaries and under wing-coverts white; feet and bill black. Wing, 1·0; tail, 1·1; bill, from forehead, 0·59; tarsus, 1·5. The bill is not normal, being longer than the head.

This species is a representative form of *D. hypoleucum*, *ex* Basilan, which is black above and larger.

32. *Nectarophila juliæ*, Tweedd. (Pl. V. figs. 2, 3).

*Nectarophila juliæ*, Tweeddale, Proc. Zool. Soc., 1877. p. 547; 1878, p. 951.

[No. 402, ♂.
No. 403, ♂.
No. 404, ♀.] Malanipa. Eyes hazel. Were quite numerous on the island, generally about the tops of the high trees.]

♂. Forehead, entire head, and nape, brilliant metallic coppery green; chin, throat, and upper breast brilliant metallic amethystine; space before the eyes black; cheeks and ear-coverts brown; lesser wing-coverts, uropygium, and upper tail-coverts brilliant metallic emerald-green; breast-feathers deep yellow, with orange-coloured tips; abdomen, vent, and under tail-coverts yellowish olive-green; under wing-coverts pale yellow and white; axillaries pale yellow; back and major wing-coverts and scapulars maroon-red; quills dark brown, externally margined with yellowish ruddy-brown; rectrices black; bill and feet black. The second example has no orange edging to the pectoral feathers.

♀. Dull olive-green above, a narrow line passing from the base of bill over the eye pale yellow; chin, throat, abdomen, vent, and under tail-coverts pale yellow; breast the same, tinged with grey; minor wing-coverts olive-green, some tipped and centred with ruddy brown; quills dark brown, margined with ruddy brown; greater wing-coverts and scapulars ruddy brown, mixed with olive-green; inner edges of some of the quills margined with white; axillaries and under wing-coverts pale yellow and white; cheeks pale yellow; ear-coverts olive-green; rectrices black, middle pair narrowly, the others broadly tipped with white, outer pair for nearly half their length white; bill and feet black.

| | Wing. | Tail. | Tarsus. | Bill, from gape. |
|---|---|---|---|---|
| ♂ . . . | 1·94 | 1·35 | 0·5 | 0·75 |
| ♀ . . . | 1·87 | 1·25 | 0·5 | 0·62 |

A true *Nectarophila*. The figures (Pl. V.) are taken from specimens 403 and 404.

33. *Arachnechthra jugularis*, Linn.

*Certhia jugularis*, Linn., S. N., vol. i. p. 185, No. 7, 1766.
*Arachnecthra jugularis*, Walden, Trans. Zool. Soc., vol. ix. p. 200; Proc. Zool. Soc., 1877, pp. 548, 698, 763, 830; 1878, pp. 112, 286, 343; 1879, p. 72.

[No. 360, ♂. Ilo-ilo. Eyes black Stomach had insects.
No. 389, ♂. } Camiguin.]
No. 390. ♂. }

These examples agree with those previously noted (*l. c.*). Not known hitherto from Camiguin.

34. *Corvus philippinus*, Bp.

*Corvus philippinus*, Bp., Compt. Rend., vol. xxxvii. p. 830, 1853; Walden, Trans. Zool. Soc., vol. ix. p. 201; Proc. Zool. Soc., 1877, pp. 548, 693, 763, 831; 1878, pp. 113, 287, 343, 381, 710, 951; 1879, p. 72.

[No. 343, ♂. Samboangan. Eyes brown.
No. 356, ♂. Ilo-ilo. Eyes black. Stomach had seeds, worms, &c.
No. 382, ♀. } Camiguin. These birds have been seen at most of the places we have
No. 383, ♀. } been at in the Philippines, and on this island they are quite abundant.]

This species has not hitherto been known to inhabit the three islands above named. The four examples in the collection cannot be separated from those which inhabit Luzon, Negros, and Cujo; and, like them, their dimensions exceed those of the single type specimen of *C. brevipennis*, Schlegel, at Leyden. *C. philippinus*, however, is nothing but a slightly smaller form of *C. validus*, *ex* Sumatra, with a greenish rather than a bluish gloss on the under plumage. The following Table shows the principal dimensions of the species from six Philippine Islands, together with those of typical examples of *C. validus*:—

*Corvus philippinus.*

| | Wing. | Tail. | Bill, from nostril. | Gonys. | Tarsus. |
|---|---|---|---|---|---|
| Luzon, ♀ | 11·50 | 8·25 | 1·50 | 1·00 | 2·25 |
| Negros, ♂ | 12·25 | 8·75 | 1·75 | 1·00 | 2·35 |
| —— ♀ | 12·13 | 8·67 | 1·67 | 1·00 | 2·35 |
| Cujo, ♀ | 11·50 | 8·00 | 1·37 | 0·90 | 2·25 |
| Camiguin ♀ | 12·25 | 8·75 | 1·75 | 1·25 | 2·25 |
| —— ♀ | 12·50 | 9·00 | 1·50 | 1·00 | 2·25 |
| Ilo-ilo, ♂ | 11·75 | 8·85 | 1·62 | 1·12 | 2·20 |
| Samboangan, ♂ | 11·81 | 8·50 | 1·62 | 1·00 | 2·20 |
| *Corvus validus*, *ex* Sumatra. | | | | | |
| Lampong, | 12·80 | 8·75 | 1·72 | 1·00 | 2·37 |
| —— | 12·75 | 8·62 | 1·62 | 0·87 | 2·30 |

*Corvus philippinus* belongs to a small group of crows differing but little from one another in tint, but separable by their dimensions, more especially that of the bills. *C. violaceus* is the smallest, then come *C. enca*, *C. philippinus*, *C. validus*, and *C. validissimus*.

35. *Calornis panayensis*, Scop.

*Muscicapa panayensis*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 96, No. 110, 1786.
*Calornis panayensis*, Walden, Trans. Zool. Soc., vol. ix. p. 205 ; Proc. Zool. Soc., 1877, pp. 549, 763, 831 ; 1878, pp. 113, 287, 343, 622, 710, 951 ; 1879, p. 72.

[No. 384, ♂.
No. 385, ♂. } Camiguin. Eyes orange. Stomach had seeds.]
No. 386, ♂.

These examples do not differ from Luzon, Negros, and Zebu individuals. The locality is new.

36. *Munia jagori*, Cab.

*Dermophyrs jagori*, Cab. J. für O., 1872, p. 316, No. 6.
*Munia jagori*, Walden, Trans. Zool. Soc., vol. ix. p. 207 ; Proc. Zool. Soc., 1877, pp. 549, 699, 764, 832 ; 1878 ; pp. 287, 343, 710, 951.

[No. 339, ♂.
No. 340, ♀. } Samboangan. Eyes brown. Stomach had seeds.]

The two Mindanao examples do not appear to be in perfect dress. The rectrices of the female are tinged with ochre. New to Mindanao.

37. *Osmotreron axillaris*, G. R. Gray.

*Treron axillaris*, G. R. Gray : Bp., Compt. Rend., vol. xxxix. p. 875, 1854.
*Osmotreron axillaris*, Walden, Trans. Zool. Soc., vol. ix. p. 211 ; Proc. Zool. Soc., 1878, pp. 549, 699, 764, 832 ; 1878, pp. 113, 287.

[No. 346, ♀. Ilo-ilo. Eyes white ; feet greenish. Stomach had fruit.]
New to Panay.

38. *Phabotreron brevirostris*, Tweedd. (Pl. VI.).

*Phabotreron brevirostris*, Tweeddale, Proc. Zool. Soc., 1877, pp. 549, 832 ; 1878, pp. 113, 344, 952 ; 1879, p. 73.

[No. 426, ♂. Pasananca. Eyes white ; feet coral-red ; bill black.]

♂. Forehead pale ruddy fulvous ; vertex pale grey, passing over into amethystine on the occiput and nape ; from the gape, passing below the eye, a black line, bordered underneath by a white line starting from below the eye and reaching to the nape ; back of the neck emerald-green, becoming yellow-green lower down ; some of the lowermost feathers being amethystine, then bluish green, terminated by yellow-green ; others yellow-green,

then amethystine, terminated with blue-green; back mixed amethystine and dull yellow-green; uropygium and upper tail-coverts dull yellow-green with scarcely any iridescence; wing-coverts the same, but tinged with amethystine; quills brown, edged with pale rufous or fulvous; tertiaries like wing-coverts, but without any iridescence; chin and throat pale ruddy fulvous like the forehead; remainder of under plumage ruddy fulvous, with an amethystine tinge on the breast and sides of neck; under tail-coverts pale French grey; under wing-coverts like abdomen, but deeper in shade; middle pair of rectrices pure amethystine, with a dark grey terminal band tinged with amethystine; remaining rectrices with a much broader terminal and pure grey band, the remaining part of each being deeply tinged with amethystine; outer pair with a broad, dark-brown subterminal band also washed with amethystine. Wing 4·75, tail, 3·50, tarsus 0·75, bill from forehead 0·72.

This is a small representative form of *P. leucotis*, from which it chiefly differs by its rufo-fulvous forehead, its pure amethystine rectrices, and its short bill.

39. *Myristicivora bicolor*, Scop.

*Columba bicolor*, Scop., Del. Fl. Faun. Insubr., vol. ii. p. 94, No. 97, 1786.
*Myristicivora bicolor*, Walden, Trans. Zool. Soc., vol. ix. p. 217; Proc. Zool. Soc., 1877, p. 550; 1878, pp. 113, 952.

[No. 395, ♂.
No. 396, ♀.
No. 397, ♀.] Malanipa. Eyes brown. These were abundant on the island but kept to the tops of the highest trees.

The two sexes are alike. The locality is new.

40. *Charadrius fulvus*, Gm.

*Charadrius fulvus*, Gm., S. N., vol. i. p. 687, No. 18, 1788; Walden, Trans. Zool. Soc., p. 226; Proc. Zool. Soc., 1877, pp. 550, 701, 767, 833; 1878, pp. 344, 711.

[No. 341, ♂.
No. 342, ♀.] Samboangan. Eyes brown. Stomach contained worms.

For the first time recorded from Mindanao.

41. *Numenius phæopus*, Linn.

*Scolopax phæopus*, Linn., S. N., vol. i. p. 243, No. 4, 1766.
*Numenius phæopus*, Walden, Trans. Zool. Soc., vol. ix. p. 232; Proc. Zool. Soc., 1877, p. 550.

[No. 375, ♂.
No. 376, ♀.] Zebu. Eyes hazel. Stomach with shells.
No. 401, ♂. Malanipa.]

A new locality.

42. *Tringoides hypoleucos*, Linn.

*Tringa hypoleucos*, Linn., S. N., vol. i. p. 250, No. 14, 1766.
*Tringoides hypoleucos*, Walden, Trans. Zool. Soc., vol. ix. p. 234; Proc. Zool. Soc., 1877, p. 550, 703; 1878, pp. 345, 624, 711.

[No. 391, ♀. Camiguin.
No. 435, ♂. Pasananca. Eyes hazel. This species was common along the banks of the stream.]

This cosmopolitan species has not been hitherto made known as an inhabitant of either Camiguin or Mindanao.

43. *Totanus incanus*, Gm.

*Scolopax incanus*, Gm., S. N., vol. i. p. 658 (1788).
*Totanus incanus*, Tweeddale, Proc. Zool. Soc., 1877, pp. 550, 768; 1878, pp. 345, 711.

[No. 405, ♂. Malanipa.]

For the first time recorded from any part of the archipelago. Pale ashy above; forehead and superciliaries, chin and throat pure white, clouded with grey on the breast and flanks. Wing 6·25. The dimensions of the wing in this species vary exceedingly. In an example (♂) from Fiji, No. 26 (*mus. nostr.*) the wing measures 7·20. Above it is dark ashy, and the grey on the breast is much deeper in tone. The Malanipa example was shot on January 30th.

44. *Gallinago stenura*, Kuhl.

*Scolopax stenura*, Kuhl, MS.; Bp., An. St. Nat., 1829.
*Gallinago stenura*, Tweeddale, Proc. Zool. Soc., 1877, p. 550.

[No. 438, ♀. Samboangan.]
Not hitherto recorded from any Philippine island.

45. *Rhynchæa capensis*, Linn.

*Scolopax capensis*, Linn., S. N., vol. i. p. 246, No. 14 (1766).
*Rhynchæa capensis*, Walden, Trans. Zool. Soc., vol. ix. p. 235; Proc. Zool. Soc., 1877, pp. 551, 703, 834; 1878, pp. 345, 953.

[No. 437, ♂. Samboangan. Eyes hazel.]
Known to inhabit the Philippines, but no exact locality hitherto recorded.

46. *Demiegretta sacra*, Gm.

*Ardea sacra*, Gm., S. N., vol. i. p. 640 (1788).
*Demigretta sacra*, Tweeddale, Proc. Zool. Soc., 1877, p. 551.

[No. 377, ♂. Zebu. Eyes orange.]

In ashy-blue plumage and in full breeding-dress.
For the first time noted as an inhabitant of a Philippine island.

47. *Larus ridibundus*, Linn.

*Larus ridibundus*, Linn., S. N., vol. i. p. 225, No. 9 (1766); v. Martens, J. für O., 1866, p. 30.
*Larus*, sp., Walden, Trans. Zool. Soc., No. 206.
*Larus ridibundus*, Tweeddale, Proc. Zool. Soc., 1877, p. 551.

[No. 363, ♂. Manila.]
Dr v. Marten's (*l. c.*) identification of the Manila specimens sent to Berlin by Jagor is thus confirmed.

48. *Sterna bergi*, Licht.

*Sterna bergi*, Licht., Verz. d. Doubl. Berl. Mus., p. 80 (1823); Tweeddale, Proc. Zool. Soc., 1877, p. 551; 1878, pp. 346, 712, 976.

[No. 345, ♂. Samboangan. Eyes black.]
New to the Philippines.

49. *Hydrochelidon hybrida*, Pallas.

*Sterna hybrida*, Pallas., Zoogr. Rosso-As., vol. ii. p. 338, No. 395 (1831).
*Hydrochelidon leucopareia*, Wald., Trans. Zool. Soc., vol. ix. p. 344; Proc. Zool. Soc., 1877, p. 551.

[No. 364, ♀. Manila.]

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## II.—*On the Birds collected in the Admiralty Islands.* By P. L. Sclater, M.A., Ph.D., F.R.S.

(Plates VII. to XI.)

(Reprinted with additions and corrections from the Proceedings of the Zoological Society of London for 1877.)

Of this little known group of islands Mr Moseley gives us the following account:[1]—The Admiralty Islands are a group consisting of one large island and numerous small ones. The group lies between latitudes 1° 50′ and 3° 10′ S., and longitudes 146° and 148° E. It forms the north-westerly termination of the long curved chain of large islands, which, stretching roughly N.E. and S.W., is composed of the New Ireland, Solomon, and New Hebrides groups. The main island of the Admiralty group is distant from New Hanover, the nearest large island of the chain, about 130 miles, and from the nearest point of New Guinea about 150 miles. The main island is oblong in form, and is about 50 miles in extreme length, and 16 in extreme breadth. The area of the entire

[1] Journ. Anthrop. Inst., 1877. See also Moseley's Naturalist on the Challenger, p. 448.

group is about 550 square miles, that is, about twice the size of the Isle of Man, and three times that of Middlesex. The main island is mostly of small elevation, but contains mountains rising to a height of about 1600 feet, which are visible to the eastward of the anchorage of the Challenger in Nares' anchorage. The examination of the islands made by the Expedition was confined to the extreme north-western portion of the northern coast of the main island in the neighbourhood of Nares Bay, and to the numerous small outlying islands, which, lying just off the coast, shelter that anchorage.

The land surface in the vicinity of Nares Bay consists of a series of low irregular ridges rising one above another, with wide flat expanses at the heads of the bays on the coast, which are scarcely or not at all raised above the sea level, and are thus in a swampy condition. The mountains appear from their form to be volcanic, and it is probable that the obsidian used by the natives for their implements comes from them. A trachytic lava was found to compose one of the outlying islands, and a similar rock was observed on the mainland where it begins to rise. A platform of coral sand rock forms the coast-line of the main island in many places, and a similar rock is the only component of most of the small outlying islands on which the greater part of the natives dwell. The Admiralty Islands, from their position with regard to the equator, have an extremely damp climate. They are densely wooded.

[The Challenger arrived at Nares Harbour, Admiralty Islands, on the 3d of March 1875, and anchored to the lee of Wild Island about 6.30 P.M. She left again on the afternoon of March 10th.]

The specimens of birds obtained during the sojourn of the Challenger at Nares Harbour are 56 in number, and embrace examples of 27 species. Of these six appear to be new to science.

| | Specimens. | Species. | New Species. |
|---|---|---|---|
| *Passeres* . . . . | 17 | 7 | 4 |
| *Coccyges* . . . . | 2 | 1 | ... |
| *Psittaci* . . . . | 10 | 1 | ... |
| *Accipitres* . . . . | 2 | 2 | ... |
| *Herodiones* . . . . | 4 | 2 | ... |
| *Steganopodes* . . . | 1 | 1 | . . |
| *Columbæ* . . . . | 8 | 2 | 2 |
| *Gallinæ* . . . . | 1 | 1 | ... |
| *Ralli* . . . . . | 1 | 1 | ... |
| *Limicolæ* . . . . | 7 | 6 | ... |
| *Gaviæ* . . . . | 3 | 3 | ... |
| | 56 | 27 | 6 |

It may be remarked that so far as we can judge by the present collection, the avifauna of the Admiralty Islands is entirely Papuan in character.

1. *Rhipidura semirubra*, Scl. (Pl. VII. fig. 2).

*Rhipidura semirubra*, Sclater, Proc. Zool. Soc., 1877, p. 552.

Supra læte castaneo-rubra; alis caudaque nigricantibus, secundariis extus et rectricibus ad basin rubris dorso concoloribus, his omnibus albo late terminatis: subtus alba, torque subgutturali et pectoris maculis quibusdam nigris; hypochondriis rufescentibus, crisso rufo; rostro nigricante, pedibus obscure cinereis; long. tota 5·5, alæ 2·8, caudæ rotundatæ rectr. ext. 2·8, med 3·0.

*Habitat.*—Ins. Admiralitatis.

*Obs.*—Species quoad formam *Rhipidura rufifronti* ex Australia similis, sed dorso toto castaneo diversa.

The collection contained a single "male" of this Flycatcher (No. 496), "insects in stomach."

2. *Monarcha inornatus*, Garnot.

*Muscicapa inornata*, Garnot, Zool. Voy. Coq., vol. i. p. 590, Atlas, t. 16, fig. 1.
*Monarcha inornata*, G. R. Gray, Proc. Zool. Soc., 1858, p. 177; Scl., Proc. Zool. Soc., 1877, p. 552.

Three skins (493, ♂; 494, ♂; and 495, ♀) of this species are in the collection. The sexes are alike.

[Eyes hazel; bill and feet indigo-blue.]

I have compared them with skins of this species collected by Wallace, in the British Museum. *Monarcha fulviventris*, Hartlaub, Proc. Zool. Soc., 1867, p. 830, of the Echiquier Islands, is nearly allied to, if not identical with, this bird.

3. *Monarcha infelix*, Scl. (Pl. VII. fig. 1).

*Monarcha infelix*, Scl., Proc. Zool. Soc., 1877, p. 552.
*Piezorhynchus infelix*, Sharpe, Cat. B., vol. iv. p. 426.

Supra nigerrimus, tectricibus alarum minoribus et capitis pone oculum et cervicis lateribus albis; subtus albus, gula et pectore toto cum faciei ante oculos lateribus nigerrimis; caudæ rectricibus lateralibus albis, mediis ad basin et ad apicem nigris; subalaribus albis; rostro et pedibus nigris; long. tota 5·8, alæ 3·2, caudæ 2·8, rem. quarto et quinto æqualibus et longissimis.

*Habitat.*—Ins. Admiralitatis.

*Obs.*—Species forma et habitu, ut videtur, *Monarchæ loricati*, sed pectore nigro et alarum tectricibus albis distinguenda.

A single specimen of this species (No. 497) was "shot on the main island; insects in stomach." Unfortunately it is in a very imperfect state, the bill and greater part of the tail-feathers having been shot away. It is *possible* that the two centre tail-feathers, which are apparently absent, may be wholly black as in *Monarcha loricatus;* the three outer ones are wholly white.

4. *Philemon albitorques*, Scl. (Pl. VIII.).

*Philemon albitorques*, Scl., Proc. Zool. Soc., 1877, p. 553.

Supra obscure fuscus, plumis subtus cinereis; alis caudaque nigricantioribus; fascia cervicis postica et toto corpore subtus albis cineraceo adumbratis; capitis plumis brevibus, rigidiusculis, fronte loris et oculorum ambitu fere denudatis; subalaribus cum ventre concoloribus; rostro nigricanti-corneo, mandibula inferiore ad basin flava; pedibus obscure cinereis; long. tota 13·5, alæ 7·3, caudæ rectr. lat. 4·2, med. 5·5, tarsi 2·0.

*Habitat.*—Ins. Admiralitatis.

*Obs.*—Species torque colli postico insignis, rostro ad basin paulum incrassato et tumido, pedibus robustis.

A single example of this fine Honeyeater (No. 481) was "shot on Wild Island." [Several others were seen, but it was difficult to get a shot at them, they fly so rapidly. They were continually heard in the woods, both of the main island and on the outward.

Female: eyes brown; feet grey; bill dark, base of the lower mandible yellow; stomach had grasshoppers.

This bird made a noise like the 'Leather-head' of Australia, but much louder.]

The specimen is moulting, both new wing- and tail-feathers being not fully developed. The breast is slightly stained with yellow, as is often the case with the Meliphagidæ.

5. *Nectarinia frenata*, S. Müll.

*Nectarinia frenata*, S. Müll, Land en Volkenk, p. 173; Scl., Proc. Zool. Soc., 1877, p. 553.

Four examples (487, male; 488, male; 489, female; and 490, female) of this rather widely spread Sun-bird (see remarks as to range, Proc. Zool. Soc., 1877, p. 104). Mr Murray notes, "eyes hazel." None of the specimens are in full dress.

6. *Myzomela pammelæna*, Scl. (Pl. VII. fig. 3).

*Myzomela pammelæna*, Scl., Proc. Zool. Soc., 1877, p. 553; Forbes, Proc. Zool. Soc., 1879, p. 267.

Nigerrima, remigum marginibus internis cineraceo-albidis, rostro et pedibus nigris: long. tota 5·0, alæ 2·7, caudæ 2·0.

*Habitat.*—Ins. Admiralitatis.

*Obs.*—Affinis *Myzomela nigritæ*, sed crassitie majore, rostro longiore et subalaribus nigris diversa.

Two specimens of this apparently new *Myzomela* (491, 492) are in the collection. The one described and figured (491) is marked "male, eyes hazel," and is evidently adult. In the other (492), apparently young, the plumage is mixed with cinereous, the feet not so dark, and the under surface of the wings more white. But the size alone is sufficient to distinguish it from its Papuan representative.

7. *Calornis purpureiceps*, Salvadori.

*Calornis*, sp. inc., Scl., Proc. Zool. Soc., 1877, p. 554.
*Calornis purpureiceps*, Salvad., Att. R. Acc. Sc., Torino, vol. xiii. p. 535, 1878.

463, male; 464, male; 465, male; 466, female; 467, female.

[Eyes orange: stomachs contained seeds and grubs. This was, perhaps, the commonest bird at the Admiralty Islands.]

Lord Tweeddale, who kindly examined these skins for me, wrote as follows:—"Nos. 463–466. The purple reflexions being restricted to the head, chin, and throat distinguishes these examples from all others known to me. They may belong to either *Calornis viridescens* (Gray), *Calornis gularis* (Gray), or *Calornis amboinensis* (Gray), for I do not possess typical examples; but I believe that all these are little more than stages of *Calornis metallica*. If they do not fall under either of these three titles, I think they may be safely described and named, for their distinctive characters are well marked."

In my report I did not venture to distinguish this bird as a distinct species, not having available materials for a study of the difficult group to which it belongs. Professor Salvadori, however, who, during a subsequent visit to London, had an opportunity of examining the specimen, has described the species as new with the subjoined diagnosis:—

Nitidissime viridis, alis et cauda obscurioribus; capite et gula tantum purpurascentibus; rostro pedibusque nigris.

Long. tot. $O^m$, 190; al. $O^m$, 108; caud. $O^m$, 080; rostri $O^m$, 018; tarsi $O^m$, 022.

*Habitat.*—Ins. Admiralitatis.

Professor Salvadori remarks that this species may be distinguished from *Calornis metallica* by its smaller dimensions, by the acuminated feathers of the anterior part of the neck being much shorter, and by the purple reflexions being confined to the head, chin, and throat.

Lord Tweeddale was of opinion that No. 467 belonged to a distinct species, and that there might have been some error as regards its locality. But Mr Murray says this is quite unlikely, and that that specimen also was certainly obtained on the Admiralty Islands.

8. *Halcyon saurophaga*, Gould.

*Halcyon saurophaga*, Gould, Proc. Zool. Soc., 1843, p. 103; Scl., *Ibid.*, 1877, p. 554.
*Halcyon albicilla*, Sharpe, Mon. Kingf., pl. lxxiii., p. 197.

Two examples (498, 499), agreeing with other specimens of this species in every respect. [Shot on D'Entrecasteau Island, one by Captain Thomson. Eyes brown; bill and feet dark; base of lower mandible flesh-coloured or white.]

9. *Trichoglossus cyanogrammus*, Wagler.

*Trichoglossus cyanogrammus*, Finsch, Papag., vol. ii. p. 830; Scl., Proc. Zool. Soc. 1877, p. 554.

Ten skins of this fine species (449–456, males; and 457, 458, females) are in the collection. The breast is of a brighter red than in an example of the same bird from Humboldt Bay, New Guinea, and the purplish edgings of the breast-feathers are wider. There is also more brown on the nape in some of the skins.

[Eyes orange; bill and feet black; seeds generally in stomachs. This was a common bird in all parts of Nares Harbour when we landed.]

10. *Haliaetus leucogaster*, Gm.

*Haliaetus leucogaster*, Sharpe, Cat., vol. i. p. 307; Scl., Proc. Zool. Soc., 1877, p. 554.

[Female (No. 478, from Maclear Island); eyes brown; cere black; bill horn-colour; claws black; legs flesh-colour: in stomach a *Calornis* and remains of a Tern.]

11. *Pandion haliaëtus*, Linn.

*Pandion haliaëtus*, Scl., Proc. Zool. Soc., 1877, p. 554; Sharpe, Cat. B., vol. i. p. 449.

[Male (No. 479) shot on D'Entrecasteau Island; stomach had fish.]

12. *Fregata ariel*, Gould.

*Fregata ariel*, Scl., Proc. Zool. Soc., 1877, p. 555.

[No. 482, male; eyes black, flesh of throat red; fish in stomach. Shot from the pinnace while hovering with others over a shoal of fish.]

13. *Nycticorax caledonicus*, Lath.

*Nycticorax caledonicus*, Gould, B. Austr., vol. vi., pl. lxiii.; Scl., Proc. Zool. Soc., 1877, p. 555.

Three specimens of this Night-heron, two adult (474, male; 475, female) and one in young plumage (476), were shot on Pigeon Island.

14. *Ardea sacra*, Gm.

*Ardea sacra*, Finsch and Hartl., Orn. Central-Polyn., p. 201 ; Scl., Proc. Zool. Soc., 1877, p. 555.

A specimen (No. 480) in grey plumage, with a few white feathers on the throat. [Eyes yellow ; legs had a yellowish tinge ; bill black.]

15. *Carpophaga rhodinolæma*, Scl. (Pl. IX.).

*Carpophaga rhodinolæma*, Scl., Proc. Zool. Soc., 1877, p. 555.

Supra æneo-viridis, alis caudaque saturatioribus, remigibus et rectricibus intus nigricantibus ; capite et cervice totis et corpore inferiore canis ; genis gulaque rosaceo indutis ; crisso obscure castaneo ; mento et oculorum ambitu anguste albis ; rostro nigro, pedibus rubris ; long. tota 12·6 ; alæ 9·3, caudæ 5·6.

*Habitat.*—Ins. Admiralitatis.

Four examples of this Fruit-Pigeon (Nos. 468, 469, 470, males ; 471, female) belonging to the group of *Carpophaga ænea* are in the collection. The figure (Pl. IX.) represents specimen 471.

The Marquis of Tweeddale, who kindly compared the birds for me with his series, wrote :—

"Apart from its dimensions, this *Carpophaga* from the Admiralty Islands, only differs from individuals of *Carpophaga ænea*, *ex* Ceylon, Malabar, Central India, Burma, the Andamans, Borneo, Java, the Philippines, and Hainan, in having no rosy or vinous tint on the grey part of the plumage, excepting on that of the throat, cheeks, and ear-coverts. In example (No. 468) this is very well marked.

"The outer webs of the primaries are not conspicuously powdered with grey as is the case in Central Indian, Burman, Javan, Bornean, Hainan, and Philippine examples. But I do not attach much importance to this difference at present, for I suspect this powdering comes on only when the quills are old, and indications are evident on some of the quills of No. 468."

Mr Murray writes :—

"These birds were in immense numbers, but more especially on a small island near the mainland, hence called 'Pigeon Island.' On the first day four guns bagged 85 in two hours ; another day 230 were taken, another 200, another 150. This island was about two acres in extent. The pigeons always returned to it from the mainland, however much they were disturbed. It would seem to have been their usual breeding place. When our first party landed the birds were so tame they could be knocked over with a stick. Their nests consisted of crossed twigs and sticks, with layers of large leaves. Some of them were on the ground under dense masses of creepers. Three eggs were obtained. The stomachs generally contained the dark scarlet berries of a wild coffee tree."

16. *Ptilopus johannis*, Scl. (Pl. X.).

*Ptilopus johannis*, Scl., Proc. Zool. Soc., 1877, p. 556.

Clare psittaceo-viridis, maculis scapularium paucis obscure cæruleis; fascia pectoris semilunari lata, ventre imo et crisso lætissime flavis; pileo et ventre medio pulcherrime lilacinis; remigibus et rectricibus subtus dilute plumbeis, harum vitta apicali dilutiore, fere albicante; rostro nigro, pedibus obscure rubris; long. tota 7·4, alæ 4·7, caudæ 2·5. Femina viridis, fere unicolor, ventre medio et crisso flavis.

*Habitat.*—Ins. Admiralitatis.

*Obs.*—Species affinis *Ptilopo bello* et *Ptilopo specioso*, sed colore pilei et ventris lilacino distincta.

Of this splendid little Fruit-Pigeon, which I have great pleasure in naming after Mr John Murray, three males (459, 460, 461) and one female (462) were "shot on Wild and D'Entrecasteaux Islands." The figures are taken from specimens 461 and 462.

[Eyes of males light yellow, of females white; feet light red or pink colour; tip of bill light green. These birds were not numerous. They were always noticed about the sago-palms, on which they seemed to be feeding.]

17. *Megapodius eremita*, Hartl. (Pl. XI.).

*Megapodius eremita*, Hartl., Proc. Zool. Soc., 1867, p. 830; Scl., Proc. Zool. Soc., 1878, pp. 290, 673.

*Megapodius hueskeri*, Cab. et Reichen, J. für O., 1876, p. 329; Scl., Proc. Zool. Soc., 1877, p. 113.

*Megapodius rubrifrons*, Scl., Proc. Zool. Soc., 1877, p. 556.

Supra olivaceo-brunneus, dorso superiore et corpore subtus nigricanti-plumbeis; ventre imo obscuriore; capitis plumis brevibus, rigidiusculis, fusco-nigris, in genis et gutture parce sparsis et cutem rubram ostendentibus; pilei parte anteriore fere omnino denudata, rubra; rostro flavo, ad basin nigricante; pedibus (in pelle) fere nigris; long. tota 11·0, alæ 8·5, caudæ 3·0, tarsi 2·4, rostri arictu 1·4.

There is a single skin of this species. [No. 472, male; eyes brown, bill yellowish, feet and legs dark horn-colour: stomach contained straw material.]

There is a second specimen in spirits. Both were shot on Pigeon Island.

In my preliminary report I described this bird as a new species, as I believed it to be. But Professor Salvadori having examined the specimen, pronounces it to be indistinguishable from *Megapodius hueskeri* of New Hanover, and *Megapodius eremita* of the Echiquier Islands, described by Dr Hartlaub in 1867 from specimens in the Museum Godefroy.

18. *Porphyrio calvus*, Vieill.[1]

*Porphyrio indicus*, Scl., Proc. Zool. Soc., 1877, p. 556.
*Porphyrio calvus*, Elliot, Str. Feath., vol. vii. p. 16.

A single "male" specimen (No. 473), apparently of this wide-ranging species, was [shot on Pigeon Island by Mr Buchanan, who says it was sitting on a tree. Stomach had seeds: eyes red; bill red; legs dull red.]

19. *Esacus magnirostris*, Temm.

*Esacus magnirostris*, Gould, B. Austr., vol. vi., pl. vi.; Scl., Proc. Zool. Soc., 1877, p. 556.

One specimen (No. 477, female), [shot on Pigeon Island: eyes yellow; bill black; stomach had shells; legs and base of the bill yellow.]

20. *Charadrius mongolicus*, Pallas.

*Charadrius mongolicus*, Harting, Ibis, 1870, p. 384; Scl., Proc. Zool. Soc., 1877, p. 556.

One example (No. 504), [female: eyes black; bill, legs, and feet black.]

21. *Strepsilas interpres*, Linn.

*Strepsilas interpres*, Scl., Proc. Zool. Soc., 1877, p. 557.

Two specimens (Nos. 500, 501, males) were obtained on the main island. [Stomachs had pieces of shell, &c. Several flocks were seen during our stay.]

22. *Numenius uropygialis*, Gould.

*Numenius uropygialis*, Scl., Proc. Zool. Soc., 1877, p. 557.

One skin (483). [Female.]

23. *Totanus incanus*, Gm.

*Totanus incanus*, Scl., Proc. Zool. Soc., 1877, p. 557.
*Actitis incana*, Finsch et Hartl., Orn. Central-Polyn., p. 182.

One example (502), [female: eyes brown; legs green; bill dark.]

24. *Tringoides hypoleucos*, Linn.

*Tringoides hypoleucos*, Scl., Proc. Zool. Soc., 1877, p. 557.

One specimen, a female, No. 503 of MS. Cat.

25. *Anous stolidus*, Linn.

*Anous stolidus*, Scl., Proc. Zool. Soc., 1877, p. 557.

A female (No. 485). [Eyes black.]

[1] Count T. Salvadori has recently founded a new species (*Porphyrio ellioti*) on this bird, which he considers distinct from *Porphyrio calvus*. (Atti R. Accad. Sc. Torino, vol. xiv. p. 1168).—P. L. S.

[This Tern was most abundant here, and could always be seen in immense numbers, feeding on the shoals of fishes.]

26. *Anous melanogenys*, Gray.

*Anous melanogenys*, Saunders, Proc. Zool. Soc., 1876, p. 670; Scl., *ibid.*, 187, p. 557.

One "female" (No. 484). [Eyes black.]

27. *Sterna bergi*, Licht.

*Sterna bergi*, Scl., Proc. Zool. Soc., 1877, p. 557.

One skin (No. 486). [Eyes black.]
Mr Howard Saunders has kindly determined the Laridæ for me.

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## III.—*On the Birds collected in Tongatabu, the Fiji Islands, Api (New Hebrides), and Tahiti.* By Dr O. Finsch, C.M.Z.S.

(Plates XII. to XVII.)

(Reprinted from the Proceedings of the Zoological Society of London for 1877. With Notes and Additions by P. L. Sclater, F.R.S.)

[The standard authority on the Birds of the South Pacific Islands is the "Beitrag zur Ornith. Faunas Central-Polynesiens" of Finsch and Hartlaub, published in 1867, to which Dr Finsch refers in the case of most of the species in the present memoir. The numerous discoveries recently made would, however, render a supplement or new edition very desirable.—P. L. S.]

### *A.* BIRDS OF TONGATABU, FRIENDLY GROUP.

These are thirty in number. They were collected on July 20, 21, and 22, 1874 Only nine species are represented in the series.

1. *Collocalia spodiopygia*, Peale.

*Collocalia spodiopygia*, F. and H., Ornith. Central-Polyn., p. 48; Layard, Proc. Zool. Soc., 1876, p. 501 (Tonga); Finsch, Journ. Mus. Godeffr., Heft xii., 1876, p. 26; Finsch, Proc. Zool. Soc., 1877, p. 723.
*Collocalia*, sp.? F. and H., Jour. f. Orn., 1870, p. 125 (nest, Tonga).

[No. 11. Tongatabu.]

[These little Swiftlets were seen flying about in numbers on every part of the island at which we were. Shot July 20.]

Judging from the difference in the structure of the nests obtained by Dr Gräffe from Tongatabu (*l. s. c.*) and those from the Fijis (Orn. Central-Polyn., p. 276, t. xiv.), I expected to find a different species of *Collocalia* inhabiting the Friendly Group; but on examining the specimens before me, I find them exactly like those from the Fijis and Navigators'. The structure of the nests seems to vary individually. (*Cf.* Finsch, Journ. f. Ornith., 1872, p. 35.)

| Long. | Alæ. | Rectr. intern. | Rectr. ext. | |
|---|---|---|---|---|
| in. lin. | in. lin. in. lin. | lin. | lin. | |
| ... | ... 4 1 | 18 | 21 | Tongatabu. |
| 3 7 | ... 4 2 | 15–18 | 19–20 | Fiji (6 specimens). |
| ... | 4 1–4 5 | 18–20 | 21–23 | Navigators' (3 specimens). |

Mr Layard enumerates *C. vanicorensis* also among the birds of Tonga, although it was not detected by him. On this latter species compare Finsch, Journ. Mus. Godeffr., Heft xii. p. 23, 1876. Its occurrence in the Fijis, which has been alleged by us (Orn. Central-Polyn., p. 47) upon the faith of a specimen sent us by Dr Gräffe, the only one we saw said to be from thence, is very doubtful.

2. *Halcyon sacra*, Gm.

*Halcyon sacra*, F. and H., Ornith. Central-Polyn., p. 32; Proc. Zool. Soc., 1869, p. 545 (Tonga); Journ. f. Orn., 1870, p. 1241 (Tonga); Layard, Proc. Zool. Soc., 1876, p. 501; Finsch, Proc. Zool. Soc., 1877, p. 723.

No. 2. Tongatabu. Male.
No. 3. ,, Male.
No. 4. ,, Female.
No. 5. ,, Female.

[Shot July 20: eyes back. These birds were in considerable numbers near the houses of the natives.]

No. 23. Tongatabu. Female.
No. 24. ,, Male.
No. 27. ,, Female.
No. 28. ,, Male.

[Shot July 21.]

No. 27 (female) has a pure white superciliary stripe; in the other specimens this is

washed more or less with cinnamon-rusty, very strongly and broadly in No. 4 (female). Nos. 2, 3, and 4 show narrow rusty margins to the upper wing-coverts, which seem not peculiar to the young birds. That both sexes are precisely alike, I can state from the dissection of specimens in alcohol. Generally Tonga specimens show a more greenish tinge on the back; but in some specimens (as 5, male, 23, female, and 24, male) the blue is as dark and as pronounced as in Fiji specimens, and in some of the latter (as 95, male, and 61, male) as greenish as in Tonga specimens. The under wing-coverts and sides in the Tonga bird are mostly pure white, but Nos. 3 and 4 show a rusty tinge.

3. *Ptilotis carunculata*, Gm.

*Certhia carunculata*, Gm., S. N., vol i. p. 783.
*Ptilotis carunculata*, F. and H., Ornith. Central-Polyn., p. 58; Proc. Zool. Soc., 1869, p. 545 (Tonga); Journ. f. Orn., 1870, p. 125 (Tonga); Gräffe, *ibid.*, p. 404 (habits); Layard, Proc. Zool. Soc., 1876, p. 501 (Tonga); Finsch, Proc. Zool. Soc., 1877, p. 724.

No. 12. Tongatabu. Male.
No. 13. ,, Male.
No. 14. ,, Female.
No. 15. ,, Female.

[Shot July 20. These are the most abundant birds on the island. They have a very clear bell-like note. Eyes black; wattle yellow.]

4. *Lalage maculosa*, Peale.

*Colluricincla maculosa*, Peale, U. S. Expl. Exped., 1st edit., 1848, p. 81, pl. xxiii. fig. 10.
*Lalage maculosa*, Finsch, Proc. Zool. Soc., 1877, p. 724.
*Lalage terat*, Cass. (*nec* Bodd.), *ibid.*, 2d edit., 1858, p. 143; F. and H., Ornith. Central-Polyn., p. 80; Proc. Zool. Soc., 1869, p. 546 (Tonga.); Journ. f. Ornith., 1870, p. 149 (Tonga.); Finsch, *ibid.*, 1872, p. 41 (Samoa); Layard, Proc. Zool. Soc., 1875, p. 433 (Fiji), 1876, p. 494 (Navigators'), and p. 502 (Tonga).
*Campephaga maculosa*, Gray, Hand-l., vol. i. p. 339, No. 5124.

No. 16. Tongatabu. Male.
No. 17. ,, Male.
[Eyes white. Common on the island. Shot July 20.]
No. 29. Tongatabu. Female. [Shot July 21.]
No. 32. ,, Male.

| No. | Long. alæ. | Caud. | Rostr. a front. | Lat. rostr. | Long. tars. | |
|---|---|---|---|---|---|---|
| | in. lin. in. lin. | in. lin. in. lin. | lin. | lin. | lin. | |
| 16. | ... 3 6 | ... 2 4 | 6 | 4 | $11\frac{1}{2}$ | |
| 17. | ... 3 7 | ... 2 4 | 5 | $3\frac{1}{2}$ | $11\frac{1}{2}$ | |
| 29. | ... 3 6 | ... 2 4 | 6 | $3\frac{1}{4}$ | 11 | |
| 32. | ... 3 8 | ... 2 5 | 5 | $3\frac{1}{2}$ | 11 | |
| 49. | ... 3 6 | ... 2 4 | 6 | $3\frac{1}{4}$ | 11 | |
| 50. | ... 3 $5\frac{1}{2}$ | ... 2 6 | *c.* 6 | 3 | 10 | |
| 113. | ... 3 3 | ... 2 2 | $5\frac{1}{2}$ | 3 | 10 | |
| | 3 1–3 5 | 2 0–2 2 | $5\frac{1}{4}$–6 | ... | $9\frac{1}{2}$–10 | Fiji (4 specimens). |
| | 3 2–3 7 | 2 0–2 6 | 6 | ... | 10–$11\frac{1}{2}$ | Upolu (5 ,, ). |
| | 3 6–3 9 | 2 3–2 5 | 6–$6\frac{1}{4}$ | ... | 10–12 | Tonga (9 ,, ). |
| | ... 3 4 | ... 2 5 | $5\frac{1}{2}$ | ... | $9\frac{1}{2}$ | *Lalage terat.* |

Among the specimens before me, Nos. 17, 32, and 49 (Fiji), are adult and fully coloured, which are very rare in collections, and give me a good opportunity of making a close comparison of them with Javan specimens of the true *Lalage terat* (Bodd.), with which the Central-Polynesian bird has hitherto been confounded. I have myself stated (J. f. Orn., 1872, p. 130) their undoubted identity; but having then seen only young and a few old specimens in bad condition, I was misled. The series before me seems to confirm the views of Mr G. R. Gray, who keeps the Polynesian bird separate.

The latter may be distinguished from *Lalage terat* by the grey or brownish-grey rump and upper tail-coverts being always barred by irregular but distinct cross-lines, the rump being of a uniform grey with faint darker traces in *Lalage terat*, by the black shaft-stripe on the white middle row of the upper wing-coverts, which is wanting in *Lalage terat*, and by the narrow brownish external margins of the primaries and first secondaries, which in the old *Lalage terat* are white. The latter besides shows a distinct greyish tinge on the breast and sides, whereas in *Lalage maculosa* the whole undersurface is pure white. The young bird, although much more like *Lalage terat*, may be distinguished by the much broader cross bands on the sides of the under-surface and on the rump.

The distribution of *Lalage maculosa* seems confined to the Central-Polynesian Islands, Fiji, Tonga, and the Navigators'.

5. *Aplonis tabuensis*, Gm.

*Aplonis marginata*, Gould, Proc. Zool. Soc., 1836, p. 73.
*Aplonis tabuensis*, Finsch, Proc. Zool. Soc., 1877, p. 725.

No. 8. Tongatabu. Male.

No. 9. Tongatabu. Female.
No. 25. „ Male.
[Shot July 28 and 21. Eyes dark red.]

6. *Ptilopus porphyraceus*, Forst.

*Ptilinopus porphyraceus*, F. and H., Ornith. Central-Polyn. p. 119; Proc. Zool. Soc., 1869, p. 547 (Tonga); Journ. f. Ornith. 1870, p. 131 (Tonga); Layard, Proc. Zool. Soc., 1876, p. 502 (Tonga).
*Ptilopus purpuratus*, Elliot, Proc. Zool. Soc., 1878, p. 525.

No. 6. Tongatabu. Male. [Eyes yellow.]
No. 7. „ Male.
[Shot July 21 and 22. These birds were very shy; though we heard them frequently it was very difficult to get a shot at them. The 'coo' of this dove is not so loud, and is much sweeter than that of the large fruit-pigeon (*Carpophaga*).]

Of this species, which is peculiar to the Friendly group, a full description and characters of distinction from the Fijian and Navigators' *Ptilinopus fasciatus* are given as cited above.

7. *Carpophaga pacifica*, Gm.

*Carpophaga pacifica*, F. and H., Ornith. Central-Polyn., p. 142; Journ. f. Ornith., 1870, p. 134 (Tonga); Layard, Proc. Zool. Soc., 1875, p. 503 (Tonga); Finsch, Proc. Zool. Soc., 1877, p. 726.

No. 18. Tongatabu. Male. Shot July 21.
[This large pigeon 'coos' very like our pigeon at home. It appears to be common but shy. Eyes red.]
No. 26. Tongatabu. Male. [Eyes red.]
No. 31. „ Female.
No. 79. Samoa. Female. [Eyes and legs red. Presented alive by the Rev. George Brown.]

The sexes are alike in plumage, but the female is without the knob on the base of the bill, and exactly agrees with specimens from the Navigators' and the Fijis; the vinaceous tinge in the male birds seems to be more strongly developed during time of incubation.

In our Ornithology of Central Polynesia, Dr Hartlaub and I erroneously united *Carpophaga oceanica*, Less., with this species; but since then we have shown (Proc. Zool. Soc., 1872, p. 101, and Journ. Mus. Godeffr. Heft viii. p. 26, 1875) that the latter is a distinct species, occurring in the islands of the Western Pacific. *Carpophaga pacifica* is confined to the Central-Polynesian Islands.

8. *Ardea sacra*, Gm.

*Ardea sacra*, F. and H., Ornith. Central-Polyn., p. 201; Journ. f. Ornith., 1870, p. 136 (Tonga); Layard, Proc. Zool. Soc., 1875, p. 503 (Tonga); Finsch, Proc. Zool. Soc., 1877, p. 726.

No. 19. Tongatabu. Female. [Eyes yellow.]

No. 20. Tongatabu. Female, young.

[Common on the reefs at low water; also met with in the woods through the island. Shot July 21.]

No. 22. Tongatabu. Male. Shot July 22.

No. 19 is white, assuming the slate-coloured dress from below and on the back; slate-blue appanage in full development.

No. 20. Slate-blue, with white chin-stripe; the scapular appanage in beginning of development.

No. 22. White, sprinkled on the neck, back, and below with single slate-blue feathers; no development of scapular appanage visible.

On several occasions I have shown that the white dress in this Heron is not dependent upon age or sex, and that at present we are not able to explain the causes of these interesting differences in coloration satisfactorily.

9. *Porphyrio samoënsis*, Peale.

*Porphyrio samoënsis* et *Porphyrio vitiensis*, Peale.
*Porphyrio vitiensis*, F. and H., Ornith. Central-Polyn., p. 172, tom. xii. fig. 3.
*Porphyrio indicus*, Cass. (*nec* Horsf., *nec* F. and H.).
*Porphyrio vitiensis*, F. and H., Journ. f. Ornith., 1870, p. 135 (Tonga); H. and F., Proc. Zool. Soc., 1871, p. 27 (Savai).
*Porphyrio samoënsis*, Finsch, Journ. f. Ornith., 1872, p. 55; Proc. Zool. Soc., 1877, p. 726.
*Porphyrio vitiensis*, Layard, Proc. Zool. Soc., 1875, p. 439 (Fiji); *ibid.* 1876, p. 497 (Navigators'), and 1876, p. 503 (Tonga).
*Porphyrio indicus*, Whitmee (*nec* Horsf.), Ibis 1875, p. 446 (Samoa).
*Porphyrio calvus*, Elliot, Stray Feath., vol. vii. p. 16.

No. 21. Tongatabu. Female. [Eyes red. The only specimen seen. Shot July 22.]

| Long. alæ. | Caud. | Rostr. a rict. | Rostr. scut. incl. | Lat. scut. | Long. tars. | Tib. | Dig. med. |
|---|---|---|---|---|---|---|---|
| in. lin. | in. | lin. | in. lin. | lin. | in. lin. | lin. | in. lin. |
| 8 6 | 3 | 16½ | 2 3 | 9 | 2 10 | 15 | 2 9 |

I have already explained (Proc. Zool. Soc., 1871, p. 27) that *Porphyrio indicus*, Horsf., does not occur in Polynesia, as has been stated by Mr Cassin, but that the Central-Polynesian Islands (Fiji, Navigators' and Friendly group) possess only one species; *Porphyrio samoënsis*, Peale. The description in the Ornithology of Central-Polynesia, p. 170, taken from a Javan specimen of the true *Porphyrio indicus*, Horsf., should therefore be cancelled altogether.

Specimens from the Fijis and Tonga group look apparently somewhat larger than those from the Navigators'; but on comparing the series of measurements given, it will be easy to see that in respect of size no specific distinction can be made out. In coloration there is also no difference.

## *B.* BIRDS OF THE FIJI ISLANDS.

These birds were shot on the island of Matuka on July 24, 1874, on the island of Kandavu on July 25, and from August 3 to 6, 1874, and on the island of Levuka from July 28 to August 1, 1874. They are 82 in number and represent 25 species.

1. *Astur rufitorques*, Peale.

*Nisus cruentus*, Schleg. (*nec* Gould), Mus. P.-B. Astures, p. 40.
*Astur cruentus*, F. and H. (*nec* Gould), Ornith. Central-Polyn., pp. 3 and 273; Layard, Proc. Zool. Soc., 1875, p. 424.
*Astur rufitorques*, Sharpe, Cat. Brit. Mus., vol. i. p. 121; Finsch, Proc. Zool. Soc., 1877, p. 727.
*Nisus rufitorques*, Schleg. Mus. P.-B. Accip., Revue, p. 80 (1873).

[No. 34. Matuka. Female. Eyes brown; several of these were seen, only two shot.

No. 35. Matuka. Female.

No. 36. „ Male. Eyes yellow.

No. 62. Kandavu. Female. Eyes yellow; shot July 27.

No. 80. Kandavu. Female. Eyes yellow, cere yellow, legs yellow; the stomach contained a portion of a lizard. Shot August 5.]

| No. | Long. alæ. | Caud. | Rostr. a cer. | Tars. | Dig. med. | |
|---|---|---|---|---|---|---|
| | in lin. | in lin. | lin. | in lin. | lin. | |
| 34 | 8 9 | 6 0 | 8 | 2 3 | 17 | |
| 35 | 8 6 | 6 2 | 8 | 2 3 | 17 | |
| 36 | 7 3 | 5 2 | 7 | 1 11 | 13 | |
| 62 | 8 10 | 6 4 | 8½ | 2 1 | 16 | |
| 80 | 8 9 | 5 10 | 9 | 2 1 | 16 | |
| | 8 9 | 6 2 | ... | 2 1 | 16 | ♀ Jun. Ovalau. |
| | 7 3 | 5 0 | 7 | 2 0 | 13½ | ♂ Viti-Levu. |
| | 8 2 | 6 0 | 8 | 2 1 | 15 | ♂ Ternate. |
| | 10 2 | 8 0 | ... | ... | ... | ♀ „ |
| | 8 6 | 6 9 | 8½ | 2 3 | 16 | Jun. Halmahera. |

In our Ornithology of Central Polynesia we followed Professor Schlegel in uniting the hawk of the Fijis with *Astur cruentus* of Australia; but, as on some other occasions, we depended too much on Professor Schlegel's authority, and Professor Schlegel has since declared himself to have been in error. Not having access to specimens, I cannot myself judge of the correctness of Professor Schlegel's new view; but the fine series now before me inclines me to believe that *Astur rufitorques* is most probably peculiar to the Fiji group, and not the same species as is distributed widely in the Malay archipelago and usually known as *Astur griseigularis* and *Astur henicogrammus*, Gray (= *Astur æquatorialis*, Wall.).

In coloration the Fiji specimens are pretty constant, all showing above a beautiful ashy-blue, beneath a fine vinaceous rufous, which latter forms also a broad neck-collar. This is less developed in No. 35, and looks rather imperfect. The under-surface in No. 62 shows a nearly obsolete undulation of narrow darker lines on the ventral region; the under wing-coverts in all the specimens before me are not "uniform white" as noted in his specific diagnosis by Mr Sharpe (*l. c.*, p. 95); but the white is washed with delicate pale vinaceous, which shows in Nos. 34 and 80 faint darker undulations. An old specimen of *Astur griseigularis* is generally conspicuously darker, slaty-brownish on the back, wings, and tail, the underparts also dark vinaceous-rufous, with perceptible narrow light cross bands (agreeing exactly with figs. 3, 4, taf. xiv., in Schleg. Vog. van Nederl. Indië). A young bird of *Astur griseigularis* hardly shows any difference from our young male (No. 36), except that the lores, cheeks, and a median stripe on the chin are decidedly ashy.

2. *Platycercus splendens*, Peale.

*Platycercus splendens*, Finsch, Mon. Papag., vol. ii. p. 237; Layard, Proc. Zool. Soc., 1875, p. 425; Ibis, 1876, p. 143 (first race only); Finsch, Proc. Zool. Soc., 1877, p. 728.

[No. 52. Kandavu. Male. Eyes red.
No. 53. „ „ „
No. 63. „ „ „
No. 112. „ „ Eyes orange, feet and bill black.
No. 64. „ Female. Eyes yellow.

These Parrots were very common in Kandavu, in large flocks, and made a screaming noise when settling on the trees.]

All the specimens agree among themselves; all show a blue neck-collar, but it differs in extent, in one (No. 112) being interrupted by green; none of them have red spots on the rump, such as are sometimes shown in *Platycercus tabuensis*. The size varies a good deal; wings 8 inches to 8 inches 8 lines.

Mr Layard (Ibis, 1876, p. 141) points out the characters of four different races of this parrot occurring in the Fijis :—

(1) The bright-crimson-bellied race, with broad blue collar, from Viti-Levu and Kandavu, being the true *Platycercus splendens*, Peale ;

(2) The Mathuata race, "maroon-bellied," with broad blue nuchal collar ;

(3) The Koro race, maroon-bellied, with the faintest trace of the blue collar ; and

(4) The Taviuni race (*Platycercus taviunensis*, Layard), "maroon-coloured and without a trace of the blue colour."

Of these I have before me only one specimen from Taviuni, which, indeed, differs strongly from *Platycercus splendens*. It has the same dark maroon-purplish coloration as *Platycercus tabuensis*, and wants the blue neck-collar ; besides it is considerably smaller (wings 7 inches 8 lines). As I have become convinced by the examination of a large series of *Platycercus tabuensis* that in this species the blue collar is also sometimes almost wanting, I think that this cannot form a specific character, even less so the purplish-red spots on the rump, which vary individually. If the smaller size should turn out to be constant, this dark form ought to be separated from the nearest-allied *Astur tabuensis* under the name of *Platycercus annæ*, Bourj. (*Platycercus taviunensis*, Layard).

3. *Platycercus personatus*, G. R. Gray.

*Platycercus personatus*, Finsch, Mon. Pap., vol. ii. p. 239 ; Proc. Zool. Soc., 1877, p. 729 ; Layard, Proc. Zool. Soc., 1875, p. 425.

[No. 78. Levuka. Female. Eyes orange, with streaks of red ; bill and legs black. This bird was purchased alive.]

4. *Domicella solitaria*, Gm.

*Domicella solitaria*, Finsch, Mon. Papag., vol. ii. p. 760 ; Proc. Zool. Soc., 1877, p. 729.
*Lorius solitarius*, F. and H., Orn. Central-Polyn., p. 23 ; Layard, Proc. Zool. Soc., 1875, p. 426.

[No. 37. Matuka. Female.
No. 38. „ „
No. 39. „ „
No. 40. „ Male.

These birds were not common, although when they were seen a good number were in company. They were especially seen about an *Erythrina* in blossom, close to the landing-place. Eyes red and yellow.

No. 89. Kandavu. Male. Eyes red ; bill and legs yellow ; stomach contained fruit.

No. 99. Kandavu. Female. Shot August 6.
No. 100. ,, Male. ,, ]

5. *Cuculus simus*, Peale.

*Cuculus simus*, F. and H., Ornith. Central-Polyn., p. 28; Layard, Proc. Zool. Soc., 1875, p. 426; Finsch, Proc. Zool. Soc., 1877, p. 729.

[No. 90. Kandavu. Upper mandible and margin of lower black, base of the under flesh-colour or reddish; eyes dull orange; feet yellow; stomach contained parts of bettles and caterpillars. Shot August 6.]

| Long. alæ. | Rectr. intern. | Rectr. ext. | Rostr. a front. | Latit. rostr. | Long. tars. | |
|---|---|---|---|---|---|---|
| in. lin. | in. lin. | in. lin. | lin. | lin. | lin. | |
| 4 7 | 4 6 | 3 0 | 7 | 4 | 8½ | No. 90. |
| 4 8 | 4 6 | 2 9 | 8 | 4½ | ... | ♂, Taviuni. |
| 4 7 | 4 10 | 2 4 | 7½ | 4 | 8 | Fiji. |
| 5 2 | 4 11 | 3 10 | 8½ | 3 | ... | (*Cuculus bronzinus.*) |

As this Cuckoo is only a migratory visitor to the Fiji group, it would be of interest to ascertain whither it resorts after leaving the islands, which at present are the only locality known for the species. Professor Schlegel seems wrong in uniting it with the Australian *Cuculus flabelliformis*, Lath., which seems to be a rather larger bird, as is also *Cuculus bronzinus*, Gray, of New Caledonia, which otherwise agrees nearly in coloration. Mr Gould has since described a Cuckoo (*Cacomantis castaneiventris*, B. of Austr., Suppl., pl. lv.) from Queensland, which, judging from the plate (apparently a little exaggerated in colour), comes very near to *Cuculus simus*, but is smaller (wings 4 inches 2 lines).

Our *Cuculus infuscatus* (Orn. Central-Polyn., p. 31, taf. v. fig. 1), corresponding in size exactly with *Cuculus simus*, will probably turn out to be a melanistic phase of the latter.

6. *Hirundo tahitica*, Gm.

*Hirundo tahitica*, F. and H., Ornith. Central-Polyn., p. 51; Layard, Proc. Zool. Soc., 1875, p. 430; Finsch, Proc. Zool. Soc., 1877, p. 730.
*Hirundo subfusca*, Gould.

[No. 45. Matuka. Female.
No. 46. ,, ,,
Eyes black.

No. 104. Kandavu. Female. Eyes, bill, and legs black; stomach contained insects.]

This short-tailed Swallow comes nearest to *Hirundo javanica*, Sparrm. (*Hirundo domicola*, Jerd.), but has a rather broader bill; the underparts below the ferruginous throat-portion are darker brownish; and the tail-feathers want the white spot on the inner web. I must mention, however, that in No. 45 the second right-hand tail-feather shows a very small pale spot on the inner web. The sexes are alike.

7. *Collocalia spodiopygia*, Peale.

*Collocalia spodiopygia*, Layard, Proc. Zool. Soc., 1877, p. 428, Fiji, habits; Finsch, Proc. Zool. Soc., 1877, p. 730.

[No. 93. Kandavu. Female.
No. 94. ,, Male.
Eyes, feet, and bill black; stomach contained parts of insects. Shot August 6.]

The Fiji specimens look a little lighter from below than those from Tonga and the Navigators'.

8. *Halcyon sacra*, Gm.

*Todirhamphus vitiensis*, Cass.
*Halcyon cassini*, F. and H., Orn. Central-Polyn., p. 40.
*Halcyon sacra* et *Halcyon cassini*, Layard, Proc. Zool. Soc., 1875, p. 427.
*Halcyon sacra*, Finsch, Proc. Zool. Soc., 1877, p. 731.

[No. 61. Kandavu. Male. Eyes and bill black.
No. 95. ,, ,, Eyes black, feet greyish; upper mandible black and margin of the under, rest of lower mandible pale red. Stomach contained a wasp and parts of other insects. Shot August 6.
No. 109. Kandavu. Male. Eyes and bill black.
No. 110. ,, ,, .]

The Fiji specimens are generally darker and of a more brilliant blue, the neck-collar is washed with rufous, as are the sides of the vent and flanks, which in the Tonga birds are, like the neck-collar, almost pure white. But these differences are in certain specimens so indistinct that thereupon no specific characters can be based. *Halcyon cassini*, Finsch and Hartl., with an ill-defined superciliary stripe, rests on individual differences which are of no specific value. But I may remark that among a very large number of specimens examined by me from the Friendly and Fiji Islands, I never met with one having a white head showing only a blue vertical spot, as is represented in the right-hand figure of Sharpe's plate of *Halcyon sacra*, which I think must still be kept separate as *Halcyon pealii*, F. and H., from the Navigators'. In size the Fiji specimens are exactly

the same as those from Tonga, and have not a longer bill, as has been stated by Mr Layard (Proc. Zool. Soc., 1876, p. 501).

9. *Myzomela jugularis*, Peale.

*Myzomela jugularis*, F. and H., Orn. Central-Polyn., p. 54, taf. vii. figs. 1, 2; Layard, Proc. Zool. Soc., 1875, p. 431; Finsch, Proc. Zool. Soc., 1877, p. 731.

[No. 43. Matuka. Male.
No. 44. ,, Female.
Eyes black. These little birds were flying in considerable numbers about a large tree covered with red blossom; only a few, however, were brought on board.
No. 59. Kandavu. Male. Eyes and legs black.
No. 60. ,, Female.
No. 85. ,, Male.
No. 86. ,, Female.
Eyes and bill black; legs a bluish tinge with soles yellow. Stomach contained portions of insects. Shot August 5.
No. 70. Kandavu. Male.]

In one female (No. 60) the red on the vertex and chin is more restricted; on the rump it is wanting in all; in No. 60 also in the vertex. No. 86 shows some red feathers on the rump, but none on the vertex.

10. *Ptilotis carunculata*, Gm. (Pl. XII. fig. 1).

*Certhia carunculata*, Gm.
*Ptilotis carunculata*, Layard, Proc. Zool. Soc., 1875, p. 432; Finsch, Proc. Zool. Soc., 1877, p. 732.

[No. 47. Matuka. Male. (Specimen figured.)
No. 48. ,, Female.
These birds (the same as Nos. 12, 13, 14, and 15 from Tongatabu) did not appear so common as in Tongatabu, and seem to be rather smaller.]

| Long. alæ. | Caud. | Rostr. a front. | |
|---|---|---|---|
| in. lin. | in. lin. | lin. | |
| 3 3 | 2 8 | 7½ | ♂ No. 47. |
| 3 3 | 2 5 | 7 | ♀ ,, 48. |

On comparing the measurements above given with those of the Tongatabu specimens, Mr Murray's opinion as to the smaller size of the Fiji birds seems to be confirmed; but a reference to the table of measurements published by me (Journ. f. Orn., 1870, p. 126), taken from 29 specimens from the Navigators' and Tonga groups (those of the latter series having been sent over in spirits, and mostly dissected by myself), will show all gradations of size, and the impossibility of separating the Fiji bird on account of its smaller dimensions. In coloration specimens from the Fijis, Tonga, and Navigators' are precisely alike.

The occurrence of the true *Ptilotis carunculata* on the Fijis (doubted by me, Journ. f. Orn., 1872, p. 36) has been already established by Mr Layard. According to this gentleman the species is confined to the island of Loma Loma. He endeavours also to introduce a new species (*Ptilotis similis*), said to be peculiar to the island of Vanua Levu; but the short diagnosis (Ibis, 1876, p. 148), "having pale yellowish grey ear-tufts instead of bright golden yellow," seems to me insufficient to distinguish it. Perhaps it will turn out to be *Ptilotis procerior*.

Mr Layard also remarks that in our Ornithology of Central Polynesia, we wrongly describe the iris to be white, as it is in fact brown or ashy-brown. As we never had an opportunity of seeing the bird alive, we could follow only the notice of Dr Gräffe, who gave the iris as "white;" but we also noticed "brown" (*Peale*), "ashy-grey" (*Latham*), and "blue-black" (*Forster*).

11. *Ptilotis procerior*, F. & H. (Pl. XII. fig. 2).

*Ptilotis procerior*, F. & H., Orn. Central-Polyn., p. 62, taf. v. fig. 3; Layard, Proc. Zool. Soc., 1875, p. 431; Finsch, Proc. Zool. Soc., 1877, p. 732.

[Nos. 73 and 74. Males. Levuka.]

This species is well distinguished from the former (*Ptilotis carunculata*) by having no true wattle, but a naked space below the ear-region, surrounded by a blackish line, and by the absence of the yellow moustache, which is always visible in *Ptilotis carunculata*. The figure (Pl. XII. fig. 2) is taken from specimen 74.

Through the Museum Godeffroy I have received many specimens for inspection from the following localities:—Ovalau, Vatu Lele, Vanua Levu, and Lavu-savu.

Young birds are of a sombre olive, without the yellowish tinge on the throat and breast. The size is also very variable, as is shown by the following table of measurements:—

| No. | Long. alæ. | Caud. | Rostr. a front. | |
|---|---|---|---|---|
| | in. lin. | in. lin. | lin. | |
| | 3 9 | 3 0 | $10\frac{1}{2}$ | Ovalau. Type of *Ptilotis procerior.* |
| | 3 10 | 2 11 | $9\frac{1}{2}$ | ,, |
| 74 | 3 5 | 2 8 | 10 | ♂ ,, (Levuka). Challenger. |
| 73 | 3 6 | 2 11 | 9 | ♂ ,, ,, ,, |
| | 3 10 | ... | 10 | ♂ Vatu Lele. Mus. Godeffr. |
| | 3 4 | 2 7 | $8\frac{1}{4}$ | ♂ ,, ,, |
| | 3 8 | 2 11 | $8\frac{3}{4}$ | ♂ Vanua Levu. ,, |
| | 3 3 | 2 7 | $8\frac{1}{4}$ | Viti. ,, |
| | 3 1 | 2 6 | $7\frac{3}{4}$ | ♀ Vanua Levu. ,, |
| | 2 10 | ... | *c.* 8 | ♀ Savu-savu. ,, |
| | 2 11 | ... | 8 | ♀ Viti. ,, |

Valuable notices on the habits of this species as observed by Mr Th. Kleinschmidt, are published in the Journ. Mus. Godeffr., Heft xii. p. 13, 1876.

12. *Ptilotis provocator*, Layard (Pl. XIII.).

*Ptilotis provocator*, Layard, Proc. Zool. Soc., 1875, p. 28; Finsch, Proc. Zool. Soc., 1877 p. 733.
*Ptilotis xanthophrys*, Finsch, Journ. Mus. Godeffr., Heft. xii. p. 5, 1876.

[No. 65. Kandavu. Male. Eyes brown. July 25. (Specimen figured, Pl. XIII. fig. 1.)
No. 66. ,, Female.
No. 67. ,, Male.
No. 68. ,, Male.
No. 83. ,, Male.
No. 84. ,, Female. (Specimen figured, Pl. XIII. fig. 2.)
Eyes brown; legs a greenish tinge; bill black. Stomach contained ants, spiders, grasshoppers.
No. 106. Kandavu. Female. Shot August 6.
No. 111. ,, Male. Eyes brown; bill black; legs a greenish tinge.]

The specimen which I described as *Ptilotis xanthophrys* was labelled "Navigators';" but this was a mistake, as this bird, which must bear Mr Layard's previous name, is confined to the Fijis.

This is a well-marked, excellent species, always characterised by the yellow patch surrounding the eye, extending to the ear-region. Even the young bird (No. 84, see Pl. XIII. fig. 2) shows this character, but differs otherwise in being underneath strongly tinged with olive-yellow, showing no whitish shafts, which form such conspicuous striæ

even on the back of the old birds. The sexes are alike. The size, as usual in this genus, varies considerably individually.

13. *Zosterops flaviceps*, Peale (Pl. XIV. fig. 1).

*Zosterops flaviceps*, Peale: F. & H., Orn. Central-Polyn., p. 52, t. vi.; Layard, Proc. Zool. Soc., 1875, p. 430; Finsch, Proc. Zool. Soc., 1877, p. 733.

[No. 71. Levuka. Female. (Specimen figured.)
No. 72. „ Male. Eyes black.]

In coloration this species is so like *Zosterops westernensis* (Quoy et Gaim.) of Australia, that Dr Hartlaub and Mr Gould could find only in the somewhat stronger bill a ground of distinction; but as the specimens now before me show only a difference of half a millimetre, this character can no longer stand. However, I now observe that the Fiji bird has the under tail-coverts of a deeper yellowish; so that I think *Zosterops flaviceps* may be kept separate until more specimens show this difference also to be of no constant value.

14. *Zosterops explorator*, Layard (Pl. XIV. fig. 2).

*Zosterops explorator*, Layard, Proc. Zool. Soc., 1875, p. 431; Finsch, Proc. Zool., Soc. 1877, p. 734.

[No. 57. Kandavu. Female. (Specimen figured.)
No. 58. „ „ Eyes black.]

The discovery of this species is due to Mr John Murray, of the Challenger Expedition. As Mr Layard has published only a short diagnosis, I think a full description will be necessary—the more so as the specimens now before me are the types.

Upper surface yellow olive-green, more yellow on the top and sides of the head and neck, changing into pure citron-yellow on the lores; chin, throat, and breast the same as the under tail-coverts; lower part of breast and remaining under surface yellowish-white; flanks distinctly washed with pale brownish-grey; under wing-coverts white; wing- and tail-feathers brown-black, narrowly margined externally with olive-green; remiges margined on their inner webs with white; there seems to be a narrow white eye-ring, surrounded by a narrower blackish one; bill blackish, lower mandible pale at base; legs plumbeous.

| Long. tot. | Alæ. | Caud. | Rostr. | Tars. |
|---|---|---|---|---|
| in. | in. lin. | lin. | lin. | lin. |
| *c.* 4 | 2½ | 16 | 5 | 7½ |

Both specimens are precisely alike.

This species comes nearest to *Zosterops xanthochroa*, Gray, from New Caledonia; but the olive-green of the upper parts inclines decidedly to yellow, and the yellow on the throat and breast is purer and brighter.

15 *Monarcha lessoni*, Quoy et Gaim.

*Monarcha lessoni*, F. & H., Orn. Central-Polyn., p. 88, taf. vii. fig. 5; Layard, Proc. Zool. Soc., 1875, p. 434; Finsch, Proc. Zool. Soc., 1877, p. 734.

[No. 87. Kandavu. Male. Bill light blue, darker at the base; legs bluish; eyes black. Stomach was crammed with broken parts of insects.

No. 103. Kandavu. Male. Shot August 6.

No. 116. ,, .]

16. *Myiagra rufiventris*, Elliot.

*Myiagra castaneiventris*, F. & H., Orn. Central-Polyn., p. 95, taf. ix. figs. 2, 3; Layard, Proc. Zool. Soc., 1875, p. 435; Finsch, Proc. Zool. Soc., 1877, p. 734.

*Myiagra rufiventris*, Elliot, Ibis, 1859, p. 393; Sharpe, Cat. B., vol. iv. p. 376, pl. xi. fig. 1.

[No. 51. Matuka. Male. Eyes black. Frequents chiefly the mangrove trees.

No. 75. Levuka. Male. Eyes black. Shot July 30.

No. 76. ,, Male.

No. 101. Kandavu. Male. Shot August 6.

No. 102. ,, Female. ,,

No. 114. ,, Female.

No. 115. ,, Male.]

I am rather surprised to find the specimen No. 101 marked "male"; for it agrees with No. 114, marked "female," whereas the female, No. 102, shows the very different plumage from the black-throated males. If these statements are based on dissection, they would tend to prove a uniformity of both sexes—a fact very strange, and opposite to all we know at present of the members of this genus.

This species is confined to the Fijis, and does not occur on the Navigators', as stated wrongly in our Polynesian Ornithology. The specimens described by us from Samoa were wrongly labelled. The representative species in the latter islands is *Myiagra albiventris*, Peale.

17. *Pachycephala vitiensis*, Gray.

*Pachycephala vitiensis*, Layard, Proc. Zool. Soc., 1875, p. 433; Ibis, 1876, p. 154; Finsch, Proc. Zool. Soc., 1877, p. 735.

[No. 69. Kandavu. Female. Eyes red. July 24.

No. 82. ,, ,, Eyes hazel; legs a bluish tinge; bill brown. Shot August 5.]

Without having male examples also on hand it is not possible to determine these specimens satisfactorily, as there has arisen a great confusion since Mr Layard pointed out the existence of five or six species in the Fijis. As the specimens are collected in Kandavu they ought to be "*Pachycephala vitiensis*," which, according to Mr Layard, is confined to this island; and, judging from Mr Gray's short description, they would belong to this species. But I may mention that the female specimen described and figured by us as *Pachycephala vitiensis* (Orn. Central-Polyn., p. 73, taf. viii. fig. 3), apparently belongs to the species described since as *Pachycephala torquata*, Layard (Proc. Zool. Soc., 1875, p. 433).

18. *Lalage maculosa*, Peale.

*Lalage maculosa*, Finsch., Proc. Zool. Soc., 1877, p. 735.

[No. 49. Matuka. Female.
No. 50. ,, ,,
No. 113. Kandavu. Male. Eyes hazel; bill blackish; legs a greenish tinge.]
On this species see above, p. 36.

19. *Aplonis vitiensis*, Layard.

*Aplonis vitiensis*, Layard, Proc. Zool. Soc., 1876, p. 502; Finsch, Proc. Zool. Soc., 1877, p. 735.
*Aplonis tabuensis*, F. & Hartl. (*nec* Gm.), Orn. Central-Polyn., p. 103, taf. x. fig. 2.

[No. 41. Matuka. Male.
No. 42. ,, Female.
Eyes dark red or brown. This is the same bird as Nos. 8, 9, 25 (*i.e.*, *Aplonis tabuensis*), from Tongatabu, and appeared to be not at all common; only two specimens were obtained. These seem smaller, and altogether a variety when compared with those from Tongatabu.]

The distinctive characters of this species (which, following Peale, we formerly erroneously described as the true *Aplonis tabuensis*), I have explained in my paper on the birds of Eua (see below).

| No. | Long. alæ. | Caud. | Rostr. a front. | |
|---|---|---|---|---|
| | in. lin. | in. lin. | lin. | |
| 41 | 3 8 | 2 1 | 7 | *Aplonis vitiensis.* |
| 42 | 3 5 | 2 0 | 6½ | |
| 8 | 4 0 | 2 3 | 8 | *Aplonis tabuensis.* |
| 25 | 4 3 | 2 6 | 7 | ,, |
| 9 | 4 1 | 2 5 | 7½ | ,, |

The comparison of the dimensions between the Fiji and Tonga specimens, given above, will show a considerable difference; but I must remark that they cannot stand as of specific value, for I have measured specimens from Tonga as small as those from Fiji, and also large specimens from Fiji.

20. *Chrysœnas victor*, Gould (Pl. XV.).

*Chrysœna victor*, Finsch, Proc. Zool. Soc., 1873, p. 733, et 1875, p. 557, et 1877, p. 736; *id.* Journ. Museum Godeffroy, Heft xii. p. 10 (1876); Layard, Proc. Zool. Soc., 1875, p. 437.

*Ptilopus victor*, Elliot, Proc. Zool. Soc., 1878, p. 568.

An old specimen in full plumage from Taviuni.

21. *Chrysœnas viridis*, Layard (Pl. XVI.).

*Chrysœna viridis*, Layard, Proc. Zool. Soc., 1875, pp. 151, 437; Finsch, Proc. Zool. Soc., 1877, p. 736.

*Ptilopus layardi*, Elliot, Proc. Zool. Soc., 1878, p. 567.

[No. 55. Kandavu. Sex not certain. Eyes yellow; legs violet; bill green.

No. 56. Kandavu.

No. 81. Kandavu. Male. Bill green; legs violet; eyes white. Stomach contained green fruit with stones. (Specimen figured Pl. XVI.)

No. 91. Kandavu. Male. Eyes white; bill green; legs violet.

No. 92. Kandavu. Male. Stomach contained a fruit about the size of a cherry, with a large hard stone. Shot August 6. This pigeon was common on Kandavu, and generally seen in pairs.]

This well-marked species, distinguished by the yellow head and under tail-coverts, is not the young of *Chrysœna luteovirens*, as erroneously supposed by me (Journ. Mus. Godeffr., Heft xii. p. 10). It seems to be confined to the island of Kandavu, and was first discovered, as Mr Layard notices, by the Challenger Expedition.

22. *Columba vitiensis*, Quoy et Gaim.

*Columba vitiensis*, F. & H., Orn. Central-Polyn., p. 137, taf. xi. fig. 2; Layard, Proc. Zool. Soc., 1875, p. 437, et 1875, p. 496; Finsch, Proc. Zool. Soc., 1877, p. 736.

[No. 54. Male. Kandavu. Eyes yellow; legs and upper part reddish, and beak, except tip, red.

No. 97. Male. Kandavu. Legs and eyes red, eyelid red; bill, base red, tip green. The stomach contained the seeds of the little red pepper so common on shore (Chili). The gizzard was quite ordinary, and contained nothing of the nature of that in Nos. 88, 96 (*Carpophaga latrans*). The first specimen we have taken of this pigeon. Shot August 6.

No. 187. Male. Kandavu.]

This pigeon seems also peculiar to the Viti group, although assigned in our book and by Mr Layard also to the Navigators' Islands. On the specific distinctness of the representative form in the latter group (*Columba castaneiceps*, Peale), *cf.* Finsch, Journ. f. Orn., 1872, p. 47.

23. *Carpophaga latrans* Peale (Pl. XVII.).

*Carpophaga latrans*, Peale: F. and H., Ornith. Central-Polyn., p. 140; Layard, Proc. Zool. Soc., 1875. p. 438; Finsch, Proc. Zool. Soc., 1877, p. 737.

[No. 88. Kandavu. Female. Cere and eyes red; legs red or purplish; bill black. The stomach contained the fruit of some tree unknown to me.[1] The coat of the stomach had hard papilla-like ossifications of a circular form, in two or three rows. These indurations are composed of a horny substance. Shot August 5.

No. 96. Kandavu. Female. Eyes red; bill black; cere red; legs purple. Stomach contained a large green fruit. Same as No. 88 Shot August 6.]

These examples agree with specimens from Viti-Levu. The species is peculiar to the Fiji group, and, according to Mr Layard, is found on nearly all of the islands.

The figure (Pl. XVII.) is taken from specimen No. 88.

24. *Ardea sacra*, Gm.

*Ardea sacra*, Layard, Proc. Zool. Soc., 1875, p. 440 (Fiji); Finsch, Proc. Zool. Soc., 1877, p. 373.

[No. 33. Matuka. Female. July 24.]

A uniform slate-coloured specimen, with white chin-stripe.

25. *Anas superciliosa*, Gm.

*Anas superciliosa*, F. and H., Orn. Central-Polyn., p. 213. Layard, Proc. Zool. Soc., 1875, p. 440; Finsch, Proc. Zool. Soc., 1877, p. 737.

*Anas pelewensis*, H. and F., Journ. Mus. Godeffr., Heft viii. p. 40, 1875.

[No. 98. Kandavu. Male. Eyes dull pink; bill black, legs flesh-colour with a salmon tinge. Stomach contained worms and mud. Shot August 6.

No. 188. Kandavu. Male.]

| | Long. alæ. | Caud. | Rostr. a front. | Altit. rostr. | Lat. rostr. | Long. tarsi. | Dig. med. |
|---|---|---|---|---|---|---|---|
| | in. lin. in. lin. | in. lin. in. lin. | lin. | lin. | lin. | lin. | lin. |
| No. 108. Fiji, . | ... 8 10 | ... 2 7 | 19½ | 7½ | 8½ | 17 | 20 |
| No. 98. Fiji, . . | ... 8 6 | ... ... | 19 | 8 | 8½ | 17 | 21 |
| Tonga, . . . | ... 8 9 | ... ... | 19 | 9 | 9 | 17 | 21 |
| Navigators', . . | ... 8 3 | ... 2 7 | 23 | ... | ... | 18 | 21 |
| Pelew, . . . | 7 8–8 6 | 2 6–3 0 | 17–19½ | 6½–7 | 8–8½ | 14–17 | 18–20 (7 spec.) |
| New Zealand, . | 9 0–9 6 | 3 1–3 4 | 20½–22 | 8 –8½ | 9–9½ | 17–18 | 21–23 (4 spec.) |

[1] [*Oncocarpus vitiensis*. See Prof. Garrod's paper in Appendix, p. 152, where the peculiar stomach of this fruit-pigeon is described.—P. L. S.]

I have already repeatedly noticed the smaller size of Central-Polynesian specimens in comparison with examples of the true *Anas superciliosa* from New Zealand. The Fiji specimens before me confirm my statement; but going again closely into the matter, I feel rather doubtful with respect to our *Anas pelewensis*. I formerly thought it possible to separate this form specifically by the buff coloration of the sides of the head, chin, and throat, and by the imperfect dark moustache-stripe always so conspicuous in New-Zealand specimens; but the Fiji specimens prove these characters not to be constant, as No. 108 agrees perfectly with the Pelew bird, whereas No. 98 shows the dark moustache. The rusty-brown longitudinal band on the outer web of the last secondaries also, as I have noticed since, is not a constant character for *Anas pelewensis*. Therefore only the smaller size remains noticeable; but in comparing the table of measurements given above it seems rather difficult to found upon this an available specific character; and I think *Anas pelewensis* cannot be allowed to be more than a scarcely smaller race.

## *C.* BIRDS OF API, NEW HEBRIDES.

[Our parties were landed for about three hours on Api, with orders not to wander far from the beach. During this time six specimens of birds were obtained, belonging to five species.]

1. *Hirundo tahitica*, Gm.

*Hirundo tahitica*, Finsch, Proc. Zool. Soc., 1877, p. 738.

[No. 120. Api. Female. Eyes, legs, and bill black. Stomach contained insects.]

This example agrees exactly with specimens from Fiji.

2. *Collocalia uropygialis*, G. R. Gray.

*Collocalia uropygialis*, G. R. Gray, Ann. and Mag. Nat. Hist., ser. 3, vol. xvii. p. 123 (New Hebrides); Finsch, Proc. Zool. Soc., 1877, p. 738.

[No. 121. Api. Male.

No. 122. Api. Male. Legs, eyes, and bill black. Stomach contained insects. These birds were in great numbers at the mouth of a small stream. They were always on the wing and difficult to shoot.]

This is a very remarkable species, of which I subjoin a description.

Upper parts black, with a very distinct dark steel-green stripe on the head, back, and shoulders, which, under certain lights, changes into steel blue-black on the wings and tail; on the rump a broad band of pure silky white; second and third tail-feathers with

a longitudinal median patch on the basal part of the inner web; chin, throat, and sides of breast and vent dull black, remaining under-parts white; under wing and tail-coverts black with steel blue-black gloss; the anterior portion of under tail-coverts black with white apical margins; bill black; feet brownish.

Male (121) exactly like, but the white spots on the second and third tail-feathers more restricted.

| Long. tot. | Alæ. | Caud. | Tars. | Dig. med. | |
|---|---|---|---|---|---|
| in. | in. lin. | lin. | lin. | lin. | |
| *c.* 3 | 3 6 | 18 | 3½ | 2½ | No. 121 |
| ... | ,, | ,, | ,, | ,, | No. 122 |

The tips of the wings extend beyond the end of the tail about 14 lines; the tail is entire.

The New Caledonian bird (*Collocalia leucopygia*, Wall., Proc. Zool. Soc., 1863, p. 384) seems to differ, as we learn from M. Verreaux's original description (*Collocalia linchi*, Verr. et Des Murs, Rev. et Mag. Zool., 1862, p. 129), specifically in the rachis of the rump-feathers being black, and in the want of the white spot on the inner web of the second and third tail-feathers.

3. *Halcyon juliæ*, Heine.

*Sauropatis juliæ*, Heine, J. f. O., 1860, p. 184.
*Halcyon juliæ*, Sharpe, Mon. Kingf., p. 227, tab. 86; Tristram, Ibis, 1876, p. 260; Finsch, Proc. Zool. Soc., 1877, p. 739.
*Dacelo grayi*, Schleg., Mus. P. B. Alced. (1863), p. 37.
*Halcyon sacra*, F. and H., Orn. Central-Polyn., p. 32 (spec. *ex* New Hebrides and New Ireland? p. 34).

[No. 117. Api. Female. Eyes black; upper mandible black, lower flesh-colour; legs greyish; the stomach contained insects, and a small molluscous shell.]

When placed among an extensive series of *Halcyon sacra*, this specimen seemed to be nothing more than a dull-coloured specimen of that species, having the greenish shine of the back exactly the same as in No. 7 (from Tongatabu); but the same dull green also prevails on the head; and this would form the only mark of distinction. The rufous band round the head is not so developed as in Sharpe's plate; there is only a buff supercilium; and the head-band is only indicated by some buff feathers; the neck-collar is white, not buff; the black band which runs from beneath the eyes round the hind neck is very narrow.

A specimen in the Bremen Museum, said to be from New Ireland (procured from Mr Frank), and described by us (*l.c.*) as *Halcyon sacra*, agrees perfectly with Sharpe's plate, and may be considered to be also *Halcyon juliæ*.

4. *Artamus melaleucus*, Forst.

*Loxia melaleuca*, Forst., Licht. Descr. Anim., 1844, p. 272.
*Artamus melaleucus*, Finsch, Proc. Zool. Soc., 1877, p. 739.

[No. 119. Api. Male. Bill light blue, the tip black; eyes hazel; legs black; the stomach contained insects, chiefly beetles.]

Exactly like specimens from New Caledonia; the wing a trifle shorter.

| Long. alæ. | Caud. | Rostr. a front. | Lat. rostr. a basi. | Long. tars. | |
|---|---|---|---|---|---|
| in. lin. | in. lin. | in. | in. | in. | |
| ... 4 9 | 2 3 | $7\frac{1}{2}$ | $4\frac{1}{2}$ | 7 | New Hebrides. |
| 4 11–5 2 | 2 5 | $7\frac{1}{2}$ | $4\frac{1}{2}$ | 8 | New Caledonia. |

The New Hebrides seems to be a new locality for this species. On its differences from the nearly allied *Artamus pelewensis*, Finsch, *cf.* Journ. Mus. Godeffr., Heft xii. p. 41, 1876.

5. *Carpophaga pacifica*, Gm.

*Carpophaga pacifica*, Gm.: Finsch, Proc. Zool. Soc., 1877, p. 740.

[No. 118. Api. Male, young. This bird was in poor condition, and had nothing in the stomach. Bill blackish-blue; legs dull red; eyes brown.]

This is a young bird, with not full-grown wings and tail-feathers (wings only 6 inches 11 lines, tail 4 inches), but in coloration exactly like older ones from the Tongas. Some of the tail-feathers and secondaries show the singular hairy filaments which denote a young bird still unable to fly.

## *D.* BIRDS OF TAHITI, SOCIETY GROUP.

The Challenger remained at Tahiti from the 18th of September till the 2d of October 1875. Sixteen specimens of birds were collected, which I refer to four species.

1. *Collocalia fuciphaga* (Thunb.).

*Collocalia cinerea*, Finsch, Journ. Mus. Godeffr., Heft xii. p. 25, 1876.
*Collocalia fuciphaga*, Wall., Proc. Zool. Soc., 1863, p. 384; Scl., Proc. Zool. Soc., 1865, p. 616; Finsch, Proc. Zool. Soc., 1877, p. 740.

[No. 559. Tahiti. Male.
No. 560. ,, ,,

No. 561. Tahiti. Female. Eyes black.]

| Long. alæ. | Rectr. interm. | Rectr. extern. | |
|---|---|---|---|
| in. lin. | lin. | lin. | |
| 4 7 | 21 | 26 | No. 559. Tahiti. |
| 4 6½ | 22 | 26 | No. 560. „ |
| 4 7 | 22 | 26 | No. 561. „ |
| 4 9 | 25 | 27 | *teste* Pelzeln. |
| 4 5 | 19 | 23 | *fuciphaga*, Java. |
| 3 11 | 18 | 20 | *vanicorensis*, Ponapé (8 ex.). |
| 4 2 | 20 | 22 | |
| 4 0 | 19 | 21 | *francica*, Bourbon. |

Having now, for the first time, an opportunity of examining specimens of the *Collocalia* of Tahiti, I find no specific distinctions from the well-known *Collocalia fuciphaga*, so widely distributed in the Indian and Malay archipelagos. The specimens before me are not of so light a greyish-brown as one would expect from the descriptions sent me by Herr von Pelzeln; on the contrary, the whole under-surface is a little darker than in Javan specimens; but the difference is so slight that no character can be based on it.

*Collocalia vanicorensis* corresponds in coloration exactly, but may perhaps be kept separate on account of the smaller size. From the latter, *Collocalia francica*, Gm. (from Bourbon and Madagascar), seems scarcely separable; only the under tail-coverts show a more intense green gloss. Mr Wallace (*l.c.*) is perhaps right in uniting also these two species with *Collocalia fuciphaga*.

2. *Halcyon veneratus*, Gm.

*Halcyon veneratus*, Sharpe, Mon. Kingf., p. 245, t. xciii.; Finsch, Proc. Zool. Soc., 1877, p. 741.

[No. 548. Tahiti. Male.
No. 549. „ „
No. 550. „ „
No. 551. „ „
No. 552. „ „
No. 553. „ Female.
No. 554. „ „
No. 555. „ „
No. 556. „ „ ]

The excellent series before me does not confirm the view that either the dark band

across the breast, or the more bluish-green, or the duller brown coloration of the upper parts is peculiar to a certain state of age or sex. All are apparently old specimens, and show every gradation in these characters.

The dull brownish tone passing into verdigris prevails in most of the specimens; only Nos. 548 (male) and 554 (female) are more of a greenish-blue, especially on the head and wings; these specimens have no dark breast-band, this being only faintly shown by rusty tips of the feathers. No. 551 (male) has scarcely any indication of a breast-band (resembling, therefore, the right-hand figure on Sharpe's plate). In Nos. 550 (male) and 552 (male) the breast-band is on a rusty ground-colour, speckled with blackish, in the remaining specimens more or less of a brownish-black.

The length of "wings," varies from 3 inches 3 lines to 3 inches 7 lines.

Mr Layard mentions *Halcyon veneratus* from Tonga (Proc. Zool. Soc., 1876, p. 501), but probably obtained the specimen here.

3. *Ptilopus purpuratus*, Gm.

*Ptilonopus purpuratus*, F. and H., Orn. Central-Polyn., p. 122; Finsch, Proc. Zool. Soc., 1877, p. 741.
*Ptilonopus taitensis*, Elliot, Proc. Zool. Soc., 1878, p. 541.

[No. 557. Tahiti. Male.
No. 558. ,, Female.
Feet violet; eyes orange; bill green at the base, tip yellow.]

I am pleased to have an opportunity of examining the *Ptilopus* of the Tahiti group, which is so rare in collections; and as the description given in the Ornithology of Central Polynesia (being copied from Peale) turns out to be incorrect in some points, I think it necessary to give a new one.

Male. Front and vertex delicate purplish-lilac, forming a pale and, not as usual in the members of this genus, a circumscript head-cap; remainder of head, neck, and under surface ashy-grey with only a very faint greenish tinge, more visible on the middle of the breast and vent; throat-feathers bifurcate in the centre tinged with pale dull yellow-greenish; lower vent whitish, under tail-feathers citron-yellow; tarsal feathers ashy-grey; back, wings, and tail bright grass-green; on the mantle and shoulders with a bronzy shine under certain lights; remiges slaty black on the outer webs, tips dark green; secondaries margined externally very narrowly with yellow; under wing-coverts ashy-grey, the under-surface of wings darker; tail-feathers with a grey cross band above the ends, scarcely visible on the outer web; tail from below ashy-grey, with an ill-defined white cross band above the end.

Female like the male.

| Long. tot. | Alæ. | Caud. | Rostr. a front. | Tars. | Dig. med. | |
|---|---|---|---|---|---|---|
| lin. | in. lin. | in. lin. | in. | lin. | lin. | |
| c. 8 | 5 5 | 2 9 | 5 | 12 | 9½ | Male. |
| ... | 5 7 | 2 9 | 4½ | 12 | | Female. |

Peale's figure is somewhat incorrect; the head appears too blue, and has no purplish-red margin; the remiges are not coloured blue.

The very interesting fact of the very localised distribution of the numerous species of the genus *Ptilonopus* in the Pacific archipelago is most strongly exemplified by this species, peculiar to the Tahiti group. The pale purplish-lilac cap and the want of the usual dark vent-spot, distinguish this species at once as regards coloration. But, besides, it is very well characterised by the form of the first primary, which gradually tapers towards its extremity, whereas in the other Polynesian species before me (*P. fasciatus*, *porphyraceus*, *pelewensis*, *ponapensis*, *perousei*, and *dupetit-thouarsi*) this feather is suddenly attenuated in the apical half.

4. *Ardea sacra*, Gm.

*Ardea sacra*, Gm.: Finsch, Proc. Zool. Soc., 1877, p. 742.

[No. 562. Tahiti. Female.
No. 563. „ „ Young.
Eyes orange; feet and legs greenish in the adult.]

No. 562 is white, strongly developing slate-blue feathers; No. 563 is slate-coloured, with a broad white chin-stripe.

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## IV.—*On the Birds collected in Ternate, Amboyna, Banda, the Ki Islands, and the Arrou Islands.* By T. Salvadori, C.M.Z.S.

(Plates XVIII to XX.)

(Reprinted from the Proceedings of the Zoological Society of London for 1878.)

The collection of birds made at the above-mentioned localities is not very large, numbering only 131 specimens, belonging to 79 species. None of these are new to

science; but some are of special interest, as having been described quite recently, or as being new to the locality where they now have been found.

I propose to treat of them separately, according to the localities.

## I. BIRDS OF TERNATE.

[The ship arrived at Ternate on the evening of the 14th October 1874, and sailed from Ternate at 11 A.M. on the 17th October 1874.]

The birds are only 13 in number, and belong to 11 species; specimens of *Lorius domicella* and *Lorius cyanauchen*, although bought alive at Ternate, must have been brought there from other localities.

1. *Scops morotensis*, Sharpe.

*Scops morotensis*, Sharpe, Cat. Strig., p. 75, pl. vii. fig. 1, 1875 (type examined); Salvad., Proc. Zool. Soc., 1878, p. 78.

[No. 325. Male. Eyes yellow. Stomach contained large grasshoppers.]

One "male" (No. 325) in the dark rufous plumage.

All the specimens from Ternate which I have seen agree better with the form from Morty than with that from Halmahera, *Scops leucospilus* (G. R. Gr.)

I know of other instances in which the birds inhabiting the small islands surrounding Halmahera, although very far one from the other, agree better *inter se* than with the form inhabiting the mainland.

2. *Tanygnathus megalorhynchus*, Bodd.

*Psittacus megalorhynchus*, Bodd., Tabl. Pl. Enl., p. 45, 1783 (*ex* Buffon, Pl. Enl., 713).
*Eclectus megalorhynchus*, Schleg. : Finsch, Die Papag., vol. ii. p. 351, 1870.
*Sanygnathus megalorhynchus*, Salvad., Proc. Zool. Soc., 1878, p. 78.

[No. 337. Male. Eyes white. Bought alive at Ternate.]

3. *Eclectus roratus*, Müll.

*Psittacus roratus*, Müll., S. N., Suppl., p. 77, 1776 (♀); Cass., Pr. Ac. Nat. Sc. Philad., 1864, p. 240, No. 52.
*Psittacus grandis*, Gm., S. N., vol. i. p. 335, No. 102, 1788 (♀).
*Eclectus grandis*, Wagl. : Finsch, Die Papag., vol. ii. p. 340, 1868.
*Eclectus polychlorus*, *ex* Batchian, Halmahera et Ternate, auctt. (*nec. Scops*) (♂); Finsch, Die Papag., vol. ii. p. 393 (*partim*), 1868.
*Eclectus roratus*, Salvad., Proc. Zool. Soc., 1878, p. 78.

[No. 336, male Eyes yellow; 361, female. This is the female of No. 336. It was purchased along with others at Ternate, and kept alive on board till the 28th October, when it was killed and skinned, as it proved a nuisance while alive.]

Two specimens bought alive at Ternate, a "male" (No. 336) green and a "female" (No. 361) red. This one is very interesting, having some green feathers among the scapularies.

Both specimens are much smaller than the birds which I have seen from Halmahera.

4. *Lorius domicella*, Linn.

*Psittacus domicella*, Linn., S. N., vol. i. p. 145, No. 26, 1766.
*Domicella atricapilla*, Wagl. : Finsch, Die Papag, vol. ii. p. 763, 1868.
*Lorius domicella*, Salvad., Proc. Zool. Soc., 1878, p. 79.

[No. 325. Male. Eyes red.]

One male (No. 335) not fully adult, bought alive at Ternate, but not a native of this island.

6. *Lorius cyanauchen*, Müll.

*Psittacus cyanauchen*, S. Müll., Verhandl. Land. en Volkenk., p. 107, 1839–1844 (type examined).
*Domicella cyanauchen*, Finsch, Die Papag., vol. ii. p. 773, 1868.
*Domicella lory mysorensis*, Meyer, Sitzb. k. Ak. Wiss. Wien, vol. lxx. p. 233, 1874.
*Lorius cyanauchen*, Salvad., Proc. Zool. Soc., 1878, p. 79.

[No. 335. Male. Eyes red.]

One "male" bought alive at Ternate, but certainly brought there from the Island of Mysore, in Geelvink Bay, where only *Lorius cyanauchen* lives in the wild state.

7. *Cyanalcyon diops*, Temm.

*Alcedo diops*, Temm., Pl. Col., p. 272, 1824 (type examined).
*Halcyon diops*, Steph. : Sharpe, Mon. Alced., pl. lxxvii., 1868–1871.
*Cyanalcyon diops*, Salvad., Proc. Zool. Soc., 1878, p. 79.

[No. 334. Male. Eyes black. Stomach had insects.]

8. *Pachycephala mentalis*, Wall.

*Pachycephala melanura* (*partim*), Bp., Consp., vol. i. p. 388 (*ex* Moluccis), 1850; G. R. Gr. (*nec.* Gould), Proc. Zool. Soc., 1860, p. 353 ; Schleg. Ned. Tijdschr. voor de Dierk., vol. iv. p. 44, 1871.
*Pachycephala albicollis*, Temm., Mus. Lugd. (*nec.* Lafr.) (Bp., *l. c.*).
*Tardus armillarus*, Temm. (Bp., *l. c.*).
*Lanius cucullatus*, Licht. (Bp., *l. c.*).
*Pachycephala mentalis*, Wall., Proc. Zool. Soc., 1863, p. 30 (type examined), Salvad. ; Proc. Zool. Soc., p. 79.
*Pachycephala nigrimentum*, G. R. Gr., Hand-list, vol. i. p. 388, sp. 5880, 1869, descr. nulla (type examined.

[No. 333. Male. Stomach had insects.]

9. *Cyrtostomus frenatus*, S. Müll.

*Nectarinia frenata*, S. Müll., Verh. Land. en Volkenk., p. 173 (note), 1843.
*Cinnyris frenatus*, Shelley, Mon. Cinnyr, part 3, 1877.
*Cyrtostomus frenatus*, Salvad., Atti R. Ac. Sc. Tor., vol. xii. p. 317, 1877; Proc. Zool. Soc., 1878, p. 79.

[No. 327. Male. Eyes brown. Stomach had insects. No. 329. Female.]

10. *Hermotimia auriceps*, G. R. Gr.

*Nectarinia auriceps*, G. R. Gr., Proc. Zool. Soc., 1860, p. 348.
*Hermotimia auriceps*, Salvad., Atti R. Ac. Sc. Tor., vol. x. p. 228, 1874; Proc. Zool. Soc., 1878, p. 80.
*Cinnyris auriceps*, Shelley, Mon. Cinnyr., part 5, 1877.

[No. 326. Male. Eyes brown. Stomach had insects.]

11. *Totanus glareola*, Linn.

*Totanus glareola*, Linn.: Salvad., Proc. Zool. Soc., 1878, p. 80.

[No. 330. Female. Eyes brown. Stomach contained shells.]

## II. BIRDS OF AMBOYNA.

[The Challenger arrived at Amboyna on Sunday, 4th October 1874, and sailed from Amboyna on the 10th October 1874, at 4 P.M.]

During the stay 25 birds were procured, representing 16 species, as follows:—

1. *Urospizias iogaster*, S. Müll.

*Falco hiogaster*, S. Müll. Verh., Land. en Volkenk., p. 110 (note), 1839-44 (type examined).
*Astur hiogaster*, Sharpe, Cat. Accipitr., p. 194, 1874.
*Urospizias iogaster*, Salvad., Proc. Zool. Soc., 1878, p. 80.

[No. 302. Male. Eyes coral-red; legs orange. Stomach had fish-bones and crabs.]

2. *Geoffroyus rhodops*, G. R. Gr.

*Psittacus fusicapillus*, Vieill., N. D., vol. xxv. p. 316, Java, 1817 (descr. falsa; type examined), (♀).
*Psittacus rhodops*, G. R. Gr., Proc. Zool. Soc., 1861, p. 436, Waigiou and Mysol (descr. nulla; type examined).
*Eclectus rhodops*, Schleg., Mus. P.-B., *Psittaci*, p. 43, 1864, Ceram, Amboyna, and Bouru.
*Pionias rhodops* (*partim*), Finsch, Die Papag., vol. ii. p. 380, 1868.
*Geoffroyus schlegeli*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 29, No. 40, Buru, Boano, Ceram, Amboyna, Arouko, Goram, Monawolka, 1877.
*Geoffroyus rhodops*, Salvad., Proc. Zool. Soc., 1878, p. 80.

[No. 304. Eyes white; bill, upper part, reddish, lower blackish.]

This species resembles *Geoffroyus aruensis* (G. R. Gr.), but it is larger, has the under wing-coverts of a darker blue, and the female has a darker brown head.

The type of *Psittacus fuscicapillus*, Vieill., is certainly a female of this species; but the description is wrong, as also the locality.

*Psittacus rhodops*, G. R. Gr. (*l.c.*), is said to be from Waigiou and Mysol; but knowing that in these islands lives a representative form, *Geoffroyus pucherani*, Bp., I thought that it could not be the same bird as *Eclectus rhodops*, Schleg., from the Ceram group; accordingly I gave to Schlegel's species the name of *Geoffroyus schlegeli*. Having, however, quite recently seen Gray's types in the British Museum, I find that they really belong to the Ceramese species; and I am quite sure that the localities Waigiou and Mysol are wrong. Those specimens no longer bear Wallace's original labels, which circumstance may explain how it is that wrong localities have been attributed to them.

3. *Ceyx lepida*, Temm.

*Ceyx lepida*, Temm., Pl. Col., 595, f. 1, Amboyna, 1836; Sharpe, Mon. Alced., pl. xlvi., part 2, 1868; Salvad., Proc. Zool. Soc., 1878, p. 81.

[No. 303. Female. Bill and legs red; eyes black. Stomach had insects.]

4. *Macropteryx mystacea*, Less.

*Cypselus mystaceus*, Less. Voy. Coq. Zool. Atlas, pl. xxii., 1826 (type examined).
*Macropteryx mystacea*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 311, sp. 1, 1877; Proc. Zool. Soc., 1878, p. 81.

[No. 298, male; 299, female. Eyes black. Stomach had insects.]

Two specimens—one "male" (No. 298), with the brown spot on the ear-coverts, and one female (No. 299), without the brown spot.

5. *Cyrtostomus zenobia*, Less.

*Cinnyris zenobia*, Less., Voy. Coq. Zool. Atlas, pl. xxx. fig. 3, 1826, i. 2, p. 679, 1828.[1]
*Cinnyris clementiæ*, Less., Dict. Sc. Nat., vol. i. p. 18, 1827.
*Cyrtostomus melanogaster*, G. R. Gr., Hand-list, vol. i. p. 112, sp. 1390, 1869 (descr. nulla).
*Cyrtostomus zenobia*, Salvad., Atti R. Ac. Sc. Tor., vol. xii. p. 319, 1877; Proc. Zool. Soc., 1878, p. 81.

[No. 308, male; 312, female; 313, male. Eyes black. Stomach contained insects.]

Three "males" (Nos. 308, 312, 313), apparently fully adult; all three have the feathers of the forehead tipped with metallic blue; one of them (No. 313) has the upper parts more greenish than the other two, which have the same parts of a rich olive-brown.

[1] I have not been able to find the type of this species in the Museum of Paris.

6. *Hermotimia aspasioides*, G. R. Gr.

*Nectarinia aspasioides*, G. R. Gr., Proc. Zool. Soc., 1860, p. 348, Amboyna.
*Hermotimia aspasioides*, Salvad., Atti R. Ac. Sc. Tor., vol. x. pp. 208, 216, 1874; vol. xii. p. 306, 1877; Proc. Zool. Soc., 1878, p. 81.
*Cinnyris aspasioides*, Shelley, Mon. Cinnyr., part 5. 1877.

[No. 314. Male. Eyes black. 312, female. Eyes black. Stomach had insects.]

Two specimens—one "male" (No. 314) not fully adult, with the green cap mixed with blue, and one "female" (No. 312).

7. *Dicæum vulneratum*, Wall.

*Dicæum vulneratum*, Wall., Proc. Zool. Soc., 1863, p. 32, note (Ceram, type examined); Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 315. Female. Eyes brown; stomach had insects and seeds. Small bird.]

This sex has not yet been described.

Fem. Superne cinereo-fusca, alis et cauda obscurioribus, paullum nitentibus; pileo præsertim frontem versus brunneo tincto; supracaudalibus rubris; inferne cinerea; gastræo medio seu gula, colli antici, pectoris abdominisque parte media cum subcaudalibus albis; rostro et pedibus fuscis.

8. *Budytes viridis*, Gm.

*Budytes viridis*, Gm.: Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 305. Male. Eyes brown; legs and bill black. Stomach had insects. 310, female; eyes brown. 313, male; eyes brown. Stomach had insects.]

Three specimens—one "male" (No. 305), and one "female" (No. 310), scarcely different; and one "male" (No. 319) with the under parts of a paler yellow, and with the back rather greyish.

9. *Macropygia amboinensis*, Linn.

*Macropygia amboinensis*, Linn.: Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 301. Male. Eyes red; feet red; bill black; fruit in stomach. 320, female. Eyes orange; stomach had seeds; legs red.]

Two specimens—one fully adult "male" (No. 301), and one "female" (No. 320). The female has the cap of a uniform cinnamon colour, the breast more reddish than the male, and no green or purplish reflections on the nape, which is finely mottled with dark brown and reddish fulvous.

10. *Charadrius fulvus*, Gm.

*Charadrius fulvus*, Gm.: Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 317. Male. Eyes hazel. Stomach contained worms and land shells.]

11. *Eudromias veredus*, Gould.

*Charadrius veredus*, Gould, Proc. Zool. Soc., 1848, p. 38; *id.* B. Austr., vol. vi., pl. xiv.
*Eudromias veredus*, Harting, Ibis, 1870, p. 209, pl. vi.; Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 318. Male. Eyes hazel. Stomach contained worms and land shells.]

12. *Ægialitis geoffroyi*, Wagl.

*Charadrius geoffroyi*, Wagl., Syst. Av., gen. *Charadrius*, sp. 19, 1827.
*Ægialitis geoffroyi*, Harting, Ibis, 1870, p. 378, pl. xi.; Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 311. Male. Eyes brown.]

13. *Tringoides hypoleucus*, Linn.

*Tringoides hypoleucus*, Linn.: Salvad., Proc. Zool. Soc., 1878, p. 82.

[No. 306. Female. Eyes hazel. Stomach had insects.]

14. *Gallinago stenura*, Kuhl.

"*Scolopax stenura*, Kuhl," Bp., Ann. Stor. Nat., vol. iii. fasc. x., 1830.
*Gallinago stenura*, Schleg. Mus. P.-B., *Scolopaces*, p. 12, 1864; Salvad., Cat. Syst. Ucc. di Borneo, p. 334, sp. 353, 1874; Salvad., Proc. Zool. Soc., 1878, p. 83.

[No. 316. Male. Eyes black. Stomach had worms.]

15. *Butorides javanica*, Horsf.

*Ardea javanica*, Horsf., Trans. Linn. Soc., vol. xiii. p. 190, 1820; Schleg. Mus. P.-B., *Ardeæ*, p. 43, 1863.
*Butorides javanica*, Salvad., Cat. Ucc. di Borneo, p. 351, sp. 370, 1874; Proc. Zool. Soc., 1878, p. 83.

[No. 300. Male. Eyes orange; legs yellow; bill black; crustacea in stomach. 309, female. Eyes yellow; legs green.]

Two specimens—one "female" (No. 300) fully adult, and a young "female" (No. 309).

16. *Casuarius galeatus*, Lath.

Two Cassowaries, apparently of this species, were procured alive at Ternate, and their skins having been subsequently preserved are in the collection.—P. L. S.

## III. BIRDS OF BANDA.

[The Challenger arrived at Banda on the 29th September 1874, and sailed from Banda on the evening of the 2d October 1874.]

Only 10 specimens, belonging to 7 species, are in the collection, which, although a very small one, is of some interest, as birds from Banda are rather scarce in Museums.

1. *Sauropatis chloris*, Bodd.

*Sauropatis chloris*, Bodd.: Salvad., Proc. Zool. Soc., 1878, p. 83.

[No. 293, male; 294, female. Eyes black; legs have a dull brown tinge; base of the lower mandible white, the rest black.]

2. *Monarcha inornatus*, Garn.

*Muscicapa inornata*, Garn., Voy. Coq. Zool. Atlas, pl. xvi. fig. 2, 1826, and i. 2, p. 591, 1828, New Guinea (type examined).
*Drymophila cinerascens*, Temm., Pl. Col., 430, f. 2, 1827, Timor (type examined).
*Monarcha fulviventris*, Hartl., Proc. Zool. Soc., 1867, p. 830, Echiquier Islands (type examined),
*Monarcha inornatus*, Salvad., Proc. Zool. Soc., 1878, p. 83; Sharpe, Cat., vol. iv. p. 431.

[No. 292. Male. Eyes brown; legs and bill slate-blue, the bill lighter than legs. Stomach contained insects.]

After having examined the types mentioned above, and having compared together many specimens from Timor, Banda, Amboyna, Goram, Tijoor, Ternate, Halmahera, Batchian, Tifore, Sula, Ki Islands, Arrou Islands, Mysol, New Guinea (Sorong, Dorei, and Mannam), Mafor, the Admiralty Islands, and the Echiquier group, I have arrived at the conclusion that they all belong to one species. The *Drymophila cinerascens*, Temm., represents the fully adult bird; and the *Muscicapa inornata*, Garn., is the young stage of the same, differing from the adult in the reddish colour of the outer edgings of the remiges. Under the name of *M. fulviventris* Hartlaub has described a specimen from the Echiquier group, with the abdomen rather pale, exactly like others from the other localities mentioned above.

3. *Rhipidura squamata*, S. Müll. (Pl. XVIII. fig. 2).

*Rhipidura squamata*, S. Müll., Verh. Land. en Volkenk., p. 189, 1839–44, Banda (type examined); Salvad., Proc. Zool. Soc., 1878, p. 84; Sharpe, Cat., vol. iv. p. 318.
*Rhipidura griseicauda*, Salvad., Ann. Mus. Civ. Gen., vol. vii. p. 924, sp. 20, 1875, Waigiou.

[No. 289. Female. Eyes hazel. Stomach contained insects.]

This species is allied to *R. rufifrons*, Lath., from Australia, from which it differs in having the forehead black in the middle and white on the sides; the tail is grey, white-tipped, and with scarcely any reddish colour near the base. S. Müller described this species with the tail brown-black, instead of grey; and this mistake made me believe that the bird from Waigiou, described by me, was different.

4. *Pachycephala phæonota*, Salvad. (Pl. XVIII. fig. 1).

*Myiolestes phajonotus*, Müll., Mus. Lugd. (type examined); Bp., Consp., vol. i. p. 358, 1850 (Banda).
*Pachycephala brunnea*, Wall., Proc. Zool. Soc., 1865, p. 478 (Banda), Salwatty (type examined).
*Pachycephala senex*, Pelz., Verh. K. Zool. Bot. Gesellsch, Wien, 1872, p. 429, Arrou (type examined).
*Pachycephala phæonota*, Salvad., Proc. Zool. Soc., 1878, p. 84.

[No. 290, male; 291, female. Eyes light hazel; legs flesh-colour. Stomach contained insects.]

The sexes are exactly alike. The figure (Pl. XVIII. fig. 1) is taken from specimen 291.

The types in the Museum of Leyden are marked "Borneo," which is a mistake. Bonaparte has given the exact locality.

This species has a very extensive range. I have seen specimens from Banda, Ceramlaut, Mysol, Salvatty, Waigiou, Mafor, Ternate, Dammar, Mareh, Motir, and Tidore. It is not quite certain that the bird described by von Pelzeln (*l.c.*) was really from the Arrou Islands.

5. *Myzomela boiei*, S. Müll.

*Nectarinia* (*Myzomela*) *boiei*, S. Müll., Verh. Land. en Volkenk., p. 172, 1839–44 (type examined).
*Myzomela boiei*, Salvad., Proc. Zool. Soc., 1878, p. 84; Forbes, Proc. Zool. Soc., 1879, p. 261.

[No. 295. Female. Eyes brown. Stomach had insects. The male of this bird had a red head, but no specimen was shot.]

6. *Zosterops chloris*, S. Müll.

*Zosterops chloris*, S. Müll. in Mus. Lugd. (type examined); Bp., Consp., vol. i. p. 398, 1850; Hartl. Journ. f. Orn., 1865, p. 24; Salvad., Proc. Zool. Soc., 1878, p. 84.

[Nos. 287, male; 288, female. Eyes brown; legs slate-colour. Stomach contained insects. In flocks on trees near the shore.]

The sexes are exactly alike.

To this species have been referred also specimens from Ternate and Bouru; but those from Ternate agree better with *Zosterops intermedia*, Wall., from Celebes, and one specimen from Bouru in the British Museum, collected by Wallace, belongs to a species not yet described.

7. *Carpophaga concinna*, Wall.

*Carpophaga chalybura*, G. R. Gr. (*nec* Bp.), Proc. Zool. Soc., 1858, pp. 187, 196 (Arrou).
"*Carpophaga chalybea*, Bp." (errore), Rosenb. Journ. f. Orn. 1864, p. 132, sp. 226 (Arrou).
*Carpophaga concinna*, Wall., Ibis, 1865, p. 383, No. 52, Matabello Island, Arrou (a small island west of), type examined; Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 200, No. 39, 1876; Proc. Zool. Soc., 1878, p. 85.
*Carpophaga roseinucha*, part., Schleg. Ned. Tijdschr. Dierk., vol. iii. p. 197, 1865.

[No. 296. Female. This bird was sent on board alive as a present to the Professor.]

## IV. BIRDS OF THE KI ISLANDS.

[The ship arrived at Ki Doulan, Ki Islands, on the morning of the 25th September 1874, and left on the morning of the 26th September.]

The birds from Ki Islands are 25, representing 14 species. They have been all collected at the little island named Dulan.[1]

The Ki Islands were quite unknown to naturalists before Wallace made a short stay there of six days in January 1857. He only obtained 13 species in all,[2] which were catalogued, together with those from the Arrou Islands, by Mr G. R. Gray.[3] Von Rosenberg made a longer stay on the Ki Islands, and collected there rather extensively; but no complete catalogue of his collection has been published. He gave an account of his visit to the Ki Islands, and of some of the birds collected there by him, in his Reis naar de Zuidoostereilanden gedaan en 1865, pp. 67–83.

Dr Beccari, in 1873, made a rather large collection of birds in the Ki Islands. Of this some of the new species have been already described by me;[4] but I propose to give a complete account of it as soon as my occupations permit.[5]

1. *Pandion leucocephalus*, Gould.

*Pandion leucocephalus*, Gould, Proc. Zool. Soc., 1837, p. 138; *id.* B. Austr., vol. i., pl. vi., 1848 Sharpe, Cat. Acciptr., p. 451, 1874; Salvad., Proc. Zool. Soc., 1878, p. 86.

[No. 268. Male. Eyes yellow; legs whitish; bill black. Stomach contained fish. Shot by Lieut. Channer; no others were seen. Shot far in the bush from the shore.]

2. *Geoffroyus keyensis*, Schleg.

*Psittacus capistratus*, G. R. Gr. (*nec* Bechst.), Proc. Zool. Soc., 1858, p. 183 (♀), Ki Islands (type examined).

*Eclectus personatus* (*partim*), Schleg. Ned Tijdschr. Dierk., vol. iii. p. 332 (A. grande forme (*partim*), p. 333), 1866; *id.* Mus. P.-B., *Psittaci*, Revue, p. 18 (*partim*), 1875.

*Pionias rhodops* (*partim*), Finsch, Die Papag., vol. ii. pp. 388, 955, 1868.

*Geoffroyus keyensis*, Schleg. MS., Finsch, Die Papag., vol. ii. p. 956; Salvad. Ann. Mus. Civ. Gen., vol. x. p. 29, sp. 37, 1877; Proc. Zool. Soc., 1878, p. 86, et Ann. Mus. Civ. di Genova, vol. xiv. p. 638.

[No 271, male; 269, 270, females. Eyes white; upper mandible red in the male, both black in the females. Stomach contained seeds and fruits.]

Three specimens, a young male (No. 271) in transitional plumage, an adult female (No. 270) with the head pale brown olive, and a not fully adult female (No. 269) with the head conspicuously tinged with green.

[1] Cosmos di Guido Cora, vol. ii., tav. ii., 1874.

[2] Ann. and Mag. Nat. Hist. (2), vol. xx. p. 473, 1857.

[3] Proc. Zool. Soc., 1858, pp. 169–198.

[4] Nuove specie di uccelli delle Isole Arrou e Kei, raccolte da Odoardo Beccari (Ann. Mus. Civ. Gen., vol. vi. pp. 73–80, 1874); Altre nuove specie di uccelli raccolte nella Nuova Guinea dal Signor L. M. D'Albertis e nelle Isole Arrou e Kei dal Dott. O. Beccari (*op. cit.*, vol. vi. pp. 308–314); Descrizione di sei nuove specie di uccelli delle Moluche, delle Kei e delle Isole Arrou (*op. cit.*, vol. vii. pp. 983–990, 1875).

[5] [Professor Salvadori has since published this memoir under the title "Catalogo degli uccelli delle Isole Kei," in the Annali del Mus. Civ. di St. Nat. di Genova, vol. xiv., August 1879.—P. L. S.]

3. *Eos rubra*, Gm.

*Domicella rubra*, Finsch, Die Papag., vol. ii. p. 786, 1868.
*Psittacus (Eos) bernsteini*, Rosenb. Nat. Tijdschr. v. Ned. Ind., vol. xxv. p. 145, 1863, Ki Islands.
*Lorius squamatus*, Schleg. (*nec* Bodd.), Mus. P.-B., *Psittaci*, p. 124, Nos. 1, 2, 1864 (types examined).
*Domicella schlegeli*, Finsch, Die Papag., vol. ii. p. 792, 1868, Ki Islands (type examined).
*Eos rubra*, Salvad., Proc. Zool. Soc., 1878, p. 86, et Ann. Mus. Civ. Genova, vol. xiv. p. 640.

[Nos. 272, male; 273, female. Eyes light red; bill dull red; legs black. Stomach contained seeds, with some insects. Only two were shot. The Professor has one of the same species alive on board, bought at Ki Doulan.

No. 324. Female. Eyes brown; legs black; bill rose-coloured. This bird was purchased alive at Ki Doulan, Ki Islands, and kept till to-day (Oct. 12, 1874) on board, and was killed on account of the noise it made.]

Three specimens—one male (No. 272) and one female (No. 273) fully adult and alike, and a female (No. 324) not fully adult, with some of the feathers of the underparts edged with blue and turning to greenish in the hidden part.

The *Domicella schlegeli*, Finsch. *l.c.* (= *Lorius squamatus*, Schleg.), was established on some young birds, which have the feathers of the underparts edged with blue; the same thing happens in the young of *Eos riciniata* and of *Eos cyanogenys*.

4. *Rhipidura assimilis*, G. R. Gr.

*Rhipidura assimilis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 176, Ki Islands (type examined); Salvad., Proc. Zool. Soc., 1878, p. 87, et Ann. Mus. Civ. Genova, vol. xiv. p. 648; Sharpe, Cat., vol. iv. p. 330.

[No. 286. Male. Insects in stomach. Eyes black.]

This species is allied to *Rhipidura isura* (Gould) from Australia, and to *Rhipidura setosa* (Q. & G.) from New Ireland and New Guinea. It differs from the first in the larger dimensions, in the paler band across the breast, and in the spot at the tip of the two outer tail-feathers less extended, and light fulvous instead of white. From *Rhipidura setosa* it is easily distinguished by the rufescent upper tail-coverts.

5. *Graucalus pollens*, Salvad. (Pl. XIX.).

*Graucalus pollens*, Salvad., Ann. Mus. Civ. Gen., vol. v. p. 75, 1874; Proc. Zool. Soc., 1878, p. 87, et Ann. Mus. Civ. Genova, vol. xiv. p. 650.
*Artamides pollens*, Sharpe, Cat., vol. iv. p. 13.

[No. 280. Female. Eyes black. Stomach contained seeds. Feet and bill black.]

This specimen agrees entirely with the typical females described by me. The species comes next to *Graucalus caledonicus* (Gm.) from New Hebrides and New Caledonia;

but it differs in the dimensions being somewhat smaller and darker in the colour. It is also allied to *Graucalus personatus* (Müll.) from Timor; but it is larger, darker, and also conspicuously different in the under wing-coverts, which are not white, but dark like the rest of the plumage.

In the British Museum I have seen a *Graucalus*, said to have been collected by Wallace in the Sulu Islands, and wrongly named *Graucalus temmincki*, which is very much like the females from the Ki Islands, except that it is a little smaller.

6. *Lalage karu*, Less.

*Lanius karu*, Less., Voy. Coq. Atlas, pl. xvi. (1826).
*Ceblepyris karu*, Less., Voy. Coq. Zool., i. 2, p. 633 (1828) (type examined).
*Lalage karu*, Hartl., Journ. f. Orn., 1865, p. 168; Salvad., Proc. Zool. Soc., 1878, p. 87, et Ann. Mus. Civ. Gen., vol. xiv. p. 651.
*Lalage leucometæna*, Sharpe, Cat., vol. iv. p. 106.

[Nos. 282, 283. Males. Eyes black. Stomach contained in the one seeds, in the other insects.]

Two specimens, one male (No. 282) fully adult, with the upper parts shining black, the under wing-coverts pure white, and the breast and the abdomen barred across; this is exactly like another specimen from Naiabui, collected by Signor D'Albertis and marked "female" (?) (Ann. Mus. Civ. Gen., vol. ix. p. 28, sp. 108, 1876). The second specimen (No. 283) is also marked "male." It is not fully adult; it has the upper parts grey, and the under wing-coverts, as well as the underparts, tinged with reddish.

I suspect that to the same species must be referred the *Ceblepyris rufiventris*, Jacq. & Pucher., and I question whether it really was from Raffles Bay. The type of this species, examined by me in the Museum of Paris, agrees entirely with two specimens from the Arrou Islands, collected by Beccari, and which are exactly like the type of *Lalage polygrammica*, G. R. Gr. also from the Arrou Islands.

7. *Dicruropsis megalornis*, G. R. Gr.

*Dicrurus megalornis*, G. R. Gr., Proc. Zool. Soc., 1858, pp. 199, 193, Ki Islands (type examined).
*Chibia megalornis*, Sharpe, Cat. Birds Brit. Mus., vol. iii. p. 242, No. 9 (1877).
*Dicruropsis megalornis*, Salvad., Proc. Zool. Soc., 1878, p. 88, et Ann. Mus. Civ. Gen., vol. xiv. p. 652.

[Nos. 274, 275. Both females. Eyes red; legs and bill black. Stomach contained insects.]

This bird and the other allied Austro-Malayan species have been united by Mr Sharpe to the genus *Chibia*, Hodgs., the type of which (*Chibia hottentotta*, Linn.) has a much longer and more acute bill, and is also very conspicuous for the tuft of silky hairs

springing from the forehead—a feature which, among the Austro-Malayan species, is only to be found in *Dicrurus pectoralis*, Wall., from the Sulu Islands.[1]

8. *Philemon plumigenis*, G. R. Gr.

*Tropidorhynchus plumigenus*, G. R. Gr., Proc. Zool. Soc., 1858, pp. 174, 191, Ki Islands (type examined).
*Philemon plumigenis*, Salvad., Proc. Zool. Soc., 1878, p. 88, et Ann. Mus. Civ. Gen., vol. xiv. p. 655.

[No. 276, male; 277, sex uncertain. Eyes brown. Stomach contained seeds.]

Both are young birds, with the feathers of the sides of the breast with broad yellow edges, and with the outer edges of the remiges tinged with olive.

9. *Calornis metallica*, Temm.

*Lamprotornis metallicus*, Temm., Pl. Col., 266, 1824, Amboyna (type examined).
*Calornis viridescens*, G. R. Gr., Proc. Zool Soc., 1858, p. 181, Arrou Islands (type examined).
*Calornis nitida*, G. R. Gr., Proc. Zool. Soc., 1858, p. 181, New Ireland (type examined).
*Calornis amboinensis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 182, Amboyna (type examined).
*Calornis gularis*, G. R. Gr., Proc. Zool. Soc., 1861, p. 431, Mysol (type examined).
*Calornis purpurascens*, G. R. Gr., Hand-list, vol. ii. p. 26, No. 6377 (1870), Goram (type examined).
*Calornis metallica*, Salvad., Proc. Zool. Soc., 1878, p. 88, et Ann. Mus. Civ. Gen., vol. xiv. p. 656.

[No. 284. Female. Eyes red. Stomach contained seeds; caught by Suhm in a spiders web.]

One fully adult "female" (No. 284), resembling a fully adult male.

This species has been found in nearly all the Moluccan and Papuan Islands, from the Sulu Islands westward to the Soloman Islands eastwards, and lives also in the northern part of Australia.

Temminck, in the text of the Planches Coloriees, says that his *Lamprotornis metallicus* was from Timor and Celebes; but this seems to be a mistake, as the typical specimens in the Museum of Leyden, examined by me, are from Amboyna. In Celebes and in Timor lives another species of the genus *Calornis*, and not *Calornis metallica*.

Specimens from the different localities do not differ specifically; those from Cape York are somewhat more purplish, but not always in the same way; one from Goram, a small island near Amboyna (*Calornis purpurascens*, Gray), is exactly like some specimens from Cape York.

[1] I think that the Austro-Malayan species may be more properly referred to a peculiar genus, which I propose to call *Dicruropsis*, characterised as follows:—Rostrum crassum, rostro specierum generis *Dissemuri* simile, sed culmine minus acuto, crassiusculo; cauda bifida divaricata, rectricibus extimis superne introrsum paullum convolutis.

Some specimens have the throat more purplish than others; one from Mysol (*Calornis gularis*, Gray), cannot be separated from others from Halmahera and Cape York.

10. *Carpophaga concinna*, Wall.

*Carpophaga concinna*, Wallace, Ibis, 1865, p. 383; Salvad., Proc. Zool. Soc., 1878, p. 89, et Ann. Mus. Civ. Gen., vol. xiv. p. 659.

[Nos. 263, 264, males; 265, 266, 267, females. Eyes between orange and a coral-red. The stomach in all contained fruit and seeds. Legs coral-red; bill black. There were a great many of these Nutmeg Pigeons shot, enough for lunch for the whole wardroom. They were very good eating.]

11. *Myristicivora bicolor*, Scop.

*Myristicivora bicolor*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 276 (1877); Proc. Zool. Soc., 1878, p. 89.

[No. 278. Male. White pigeon; eyes brown. Stomach contained fruit. Feet blue; bill black.]

This bird has the under tail-coverts entirely white.

In a recent paper of mine[1] I have shown that *Myristicivora bicolor* (Scop.), *Myristicivora spilorrhoa* (G. R. Gr.), and *Myristicivora melanura* (G. R. Gr.), are perfectly distinct species, and that *Myristicivora bicolor* (Scop.), most likely is a migratory bird in the Moluccas, as it is in Celebes, and that, while in Celebes it is to be found together with *Myristicivora luctuosa* (Reinw.), in the Moluccas it lives together with *Myristicivora melanura* (Gray).

12. *Macropygia keyensis*, Salvad.

*Macropygia*, sp., Wall., Ann. and Mag. Nat. Hist. (2), vol. xx. p. 473 (*partim*), 1875, Ki Islands.

*Macropygia phasianella* (*partim*), G. R. Gr. (*nec* Temm.), Proc. Zool. Soc., 1858, pp. 187, 196, Ki Islands; Wall., Ibis, 1865, p. 389, sp. 81 (*partim*); Rosenb., Reis naar zuidoostereil, p. 81 (1867).

*Macropygia turtur* (*partim*), Schleg., Mus. P.-B., *Columbæ*, pp. 110, 113, 114 (specimina Ins. Key), 1873.

*Macropygia keyensis*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 204, sp. 64 (1876); Proc. Zool. Soc., 1878, p. 89, et Ann. Mus. Civ. Gen., vol. xiv. p. 662.

[No. 279. Male. Eyes hazel. Stomach contained seeds; legs red; bill black.]

[1] Osservazioni intorno alle speci del genere *Myristicivora*, Rchb. (Ann. Mus. Civ. Gen., vol. ix. pp. 265–277).

I named this Ki Island's species (*l.s.c.*) before seeing a fully adult bird, feeling quite confident, from Schlegel's description, that it was really distinct. I have recently examined the adult specimens contained in the Leyden Museum, and I am satisfied that the Ki Island's bird belongs to a peculiar form. I shall now give a full description of the adult bird collected during the Challenger Expedition, and shall proceed afterwards to point out its principal differences from the allied forms.

Capite rufo-vinaceo, sincipite et genis pallidioribus; vertice et occipite grisescentibus; collo postico viridi et purpureo nitente, conspicue cinerascente; dorso, uropygio, supracaudalibus alarumque tectricibus exterioribus brunneo-cinnamomeis, punctulis nigris obsoletis adspersis; gula rufescenti-albida; collo antico et pectore summo vinaceis, fasciolis transversis nigris notatis; pectore imo et abdomine albido-fulvescentibus, fasciolis transversis nigris notatis; abdominis lateribus et subcaudalibus brevioribus pallide cinnamomeis, nigro transfasciolatis; subcaudalibus longioribus et tectricibus alarum inferioribus cinnamomeis unicoloribus; remigibus fuscis, exterius cinnamomeo limbatis; cauda superne brunneo-grisescente, inferne pallidiore et magis grisescente; rectricibus tribus utrinque lateralibus partim læte rufis, fascia lata subapicali nigra notatis; rostro nigro; pedibus rubris.

Long. tot. circa $0^{m}{\cdot}370$; al. $0^{m}{\cdot}018$; caud. $0^{m}{\cdot}190$; rostr. $0^{m}{\cdot}018$; tarsi $0^{m}{\cdot}021$.

This species is intermediate between *Macropygia amboinensis*, Linn., and *Macropygia doreya*, Bp.

It differs from *Macropygia amboinensis* (which it much resembles in the light underparts) :—

1st. In the greyish tinge of the vertex, of the occiput, and of the hind neck;

2d. In the more vinaceous colour of the front neck;

3d. In the more whitish underparts;

4th. In the darker hue of the back;

5th. In the larger dimensions.

From *Macropygia doreya*, Bp., to which it bears a great resemblance in the upper parts, it differs :—

1st. In the more greyish hind neck;

2d. In the much less vinaceous front neck and upper breast;

3d. In the more whitish underparts;

4th. In the lighter and more greyish tail;

5th. In the larger dimensions.

13. *Tringoides hypoleucus*, Linn.

*Tringoides hypoleucus*, Linn. : Salvad., Proc. Zool. Soc., 1878, p. 90.

[No. 285. Eyes black. Stomach contained portions of shells.]

14. *Numenius uropygialis*, Gould.

*Numenius uropygialis*, Gould: Salvad., Proc. Zool. Soc., 1878, p. 90.

[No. 281. Female. Eyes black. Stomach contained crustacea (crabs).]

In my Catalogue of the Birds of Borneo I have referred this eastern form to *Numenius phæopus*, Linn.; but now I think that *Numenius uropygialis*, Gould, with the uropygium constantly mottled with dark grey, is entitled to specific rank.

## V. BIRDS OF THE ARROU ISLANDS.

[The ship arrived at Dobbo, Arrou Islands, about noon on the 16th September 1874. The same afternoon some birds were shot near the village of Dobbo; these were all put in spirits. On the 17th a large party landed on the island of Wokan and shot thirty-two specimens. On the 19th September thirteen specimens were shot at Wanumbai, and on the afternoon of the 22d and morning of the 23d seventeen more. The ship left Arrou on the morning of the 23d September 1874, at 6 P.M.]

The birds collected in the Arrou Islands are 61, belonging to 40 species; they are from three different localities—Wokan, Wanumbai, and Dobbo, already visited by Wallace, Von Rosenberg, or Beccari.

Only one species, *Drymaædus beccarii*, lately described by me from the Arfak Mountains, is new to the islands.

1. *Cuncuma leucogaster*, Gm.

*Haliaëtus leucogaster*, Sharpe, Cat. Accipitr., p. 307 (1874).
*Cuncuma leucogaster*, Salvad., Proc. Zool. Soc., p. 91.

[No. 262. Female. Eyes yellow. Stomach contained fish. Shot on Wokan on 21st September. Skinned by Crosbie.]

This bird is in transitional plumage, like the specimen figured by Schlegel, Valkvog., pl. iv. fig. 2.

2. *Haliastur girrenera*, Vieill.

*Haliaëtus girrenera*, Vieill., Gal. Ois., vol. i. p. 31 (syn. emend.), pl. x. (1825) (type? examined); Salvad., Proc. Zool. Soc., 1878, p. 91.

[No. 235. Male. Eyes red; stomach contained crabs and cuttlefish. Shot on Wokan.]

I have found in the Museum of Paris a specimen marked "Papous (Freycinet, 1820)," which seems to be the type of Vieillot.

3. *Urospizias poliocephalus*, G. R. Gr.

*Accipiter poliocephalus*, G. R. Gr., Proc. Zool. Soc., 1858, pp. 170, 189, Arrou Islands (type examined); Sclat., Ibis, 1859, p. 276, 1860, p. 322, pl. x. (fig. avis adultæ tantum); Rosenb., Nat. Tijdschr. Ned. Ind., vol. xxv. p. 228, No. 47 (1863); *id.* Journ. f. Orn., 1864, p. 116, No. 47; Kaup, Proc. Zool. Soc., 1867, p. 177; Wall., Ibis, 1868, p. 12 (*partim*); Salvad., Ann. Mus. Civ. Gen., vol. vii. p. 75, sp. 7, Ansus (1875).

*Nisus poliocephalus*, part., Finsch, New Guin., p. 155 (1865); Schleg., Ned. Tijdschr. Dierk., vol. iii. p. 326 (*partim*) (1866); *id.* Mus. P.-B. Revu. Accipitr., p. 88 (1873); Gieb. Thes. Orn., vol. ii. p. 711 (1875).

*Urospiza poliocephalus*, G. R. Gr., Hand-list, vol. i. p. 34, sp. 336 (1869).

*Astur poliocephalus*, Rosenb., Reis naar zuidoostereil., p. 36 (1862); Sharpe, Cat. Accipitr., p. 117 (specim. *a*, *b* tantum) (1874).

*Urospizias poliocephalus*, Gurn., Ibis, 1875, p. 365; Salvad., Proc. Zool. Soc., 1878, p. 91.

*Astur contumax*, Rosenb., Reis naar zuidoostereil., p. 36, Arrou, descr. nulla (1867).

*Urospizias spilothorax*, Salvad., Ann. Mus. Civ. Gen., vol vii. p. 900, sp. 1 (1875), Arfak and Jobi, vol. x. pp. 115, 117, sp. 5 (1877).

*Accipiter etorques*, part., Sclat., Proc. Zool. Soc., 1877, p. 109, No. 45 (young specimen).

[No. 253. Male, from Wanumbai.]

This bird is young.

I have found in the museums of Leyden and Berlin two specimens which are very much like my *Urospizias spilothorax;* but they have only a few longitudinal dark spots on the lower part of the breast, showing that these spots are not a permanent character, and that my *Urospizias spilothorax* represents only a stage of *Urospizias poliocephalus.*

4. *Microglossus aterrimus*, Gm.

*Microglossus aterrimus* (Gm.): Salvad., Proc. Zool. Soc., 1878, p. 92.

[No. 206. Wokan. Male. Eyes black; cheek-membrane red. Stomach contained many of the insides of kernels of nuts. This was shot on the top of one of the highest trees. Only one seen at the time.]

I have seen many specimens from the Arrou Islands, and these are in general much smaller than those from New Guinea; and I think that the type of *Psittacus alecto*, Temm., which I have seen in the Museum of Leyden, must have come from the Arrou Islands.[1] I do not think that there is more than one species of the genus *Microglossus.*

5. *Cyclopsittacus melanogenys*, Rosenb.

"*Psittacula melanogenia*, Rosenb.": Schleg., Ned. Tijdschr. v. Dierk., vol. iii. p. 330 (1866), Arrou (type examined); Rosenb., Nat. Tijdschr. Ned. Ind., vol. xxix. p. 142 (1867).

*Psittacula melanogenys*, Finsch, Die Papag., vol. ii. p. 626 (1868).

*Cyclopsittacus melanogenys*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 29, sp. 33 (1877); Proc. Zool. Soc., 1878, p. 92.

[No. 207. Wokan. Female. Eyes black; legs with a greenish tinge.

[1] The specimen in the Berlin Museum, which has been regarded as a second one of *Microglossus alecto* looks smaller than the New Guinea specimens from having had the primaries cut off.

No. 208. Wokan. Probably a male; but the specimen was too much injured to determine.]

The example, without indication of the sex, is most likely a female, having the ear-coverts orange.

6. *Eclectus polychlorus*, Scop.

*Psittacus polychlocus*, Scop., Del. Flor. et Faun. Insubr., p. 87, n. 27 (1786) (*ex* Sonnerat), ♂.
*Eclectus linnæi*, Wagl. Mon. Psitt., p. 571, t. xxi. (1832), ♀.
*Eclectus polychlorus*, var. *aruensis*, G. R. Gr. Proc. Zool. Soc., 1858, p. 183.
*Eclectus polychlorus*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 31, sp. 7 (1877); Proc. Zool. Soc., 1878, p. 92.

[No. 212. Wokan. Male. Eyes orange; upper mandible red towards the base, and whitish-yellow towards the tip; lower one jet-black. Stomach contained inside-coating of cocoa-nut, and some pieces of coral. Feet black.]

Mr G. R. Gray considered the Arrou specimens as forming a peculiar race of *Eclectus polychlorus*, on account of the yellowish band at the tip of the tail being more conspicuous and tinged with reddish; but the differences are very slight and not constant.

7. *Chalcopsittacus scintillatus*, Temm.

*Psittacus scintillatus*, Temm., Pl. Col., p. 569 (1835), Lobo, juv. (type examined).
*Chalcopsitta rubrifrons*, G. R. Gr., Proc. Zool. Soc., 1858, p. 182, Arrou (type examined).
*Domicella scintillata*, Finsch, Die Papag., vol. ii. p. 752 (1868).
*Chalcopsittacus scintillatus*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 34, sp. 75 (1877); Proc. Zool. Soc., 1878, p. 93.

[No. 213. Wokan. Male. Eyes dull red; feet black; both mandibles black. Stomach quite empty.

No. 229. Wokan. Male. Eyes orange; feet and bill black. Stomach contained insects and leaves.]

Both specimens are fully adult.

8. *Trichoglossus nigrigularis*, G. R. Gr. (Pl. XX.).

*Trichoglossus nigrigularis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 183, Arrou (type examined); Salvad., Proc. Zool. Soc., 1878, p. 93.
*Trichoglossus cyanogrammus*, part., Finsch, Die Papag., vol. ii. p. 830 (1868).

[No. 237. Wokan. Male. Eyes red; bill red; legs slate-colour. Stomach contained small seeds. Shot at Wokan.]

This species, although not confined to the Arrou Islands and to the Ki Islands, as I have previously stated (*l.c.*), having been found quite recently along the Fly River, is quite distinct from *Trichoglossus cyanogrammus* (Wagl.), with which it has been assimilated by Wallace, Schlegel, and Finsch.

I have seen many specimens of both species, and I have found that *Trichoglossus nigrigularis* constantly differs from *Trichoglossus cyanogrammus*:—

1st. In the red of the breast inclining to orange, paler and with a most conspicuous yellow tint near the dark edges of the feathers.

2d. The dark edges of the breast-feathers are much narrower, as in *Trichoglossus massenæ*.

3d. The head above has only two colours, blue in the anterior half, greenish in the other half; while in *Trichoglossus cyanogrammus* the head above has three colours, blue on the sinciput, green on the vertex, and purplish-brown on the occiput, like *Trichoglossus massenæ*.

4th. The middle of the abdomen is generally blackish.

5th. The dimensions are larger.

The Ki Islands' specimens are a little larger than those from the Arrou Islands.

9. *Sauropatis chloris*, Bodd.

*Halcyon sordida*, var., G. R. Gr., Proc. Zool. Soc., 1858, p. 172 (Arrou).
*Sauropatis chloris*, Salvad., Proc. Zool. Soc., 1878, p. 94.

[No. 244. Dobbo. Female. Legs slate, with a slightly bluish tinge; eyes black. Shot on Dobbo on the 20th September 1874.]

This bird has the upper parts very dark, and in that respect approaches *Sauropatis sordida* (Gould), to which Mr Gray thought that the Arrou birds should be referred; but I have seen other specimens from the Arrou Islands with the upper parts of a much brighter colour, exactly like others from Amboyna, Bouru, and other localities.

The true *Sauropatis sordida* (Gould) is a much larger bird.

10. *Sauropatis sancta*, Vig. and Horsf.

*Halcyon sanctus*, Sharpe, Mon. Alced., pl. xci. (1868–71).
*Sauropatis sancta*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 306, sp. 35 (1877); Proc. Zool. Soc., 1878, p. 94.

[No. 219. Wokan. Male (young). Eyes black; upper mandible and edge of lower black, under base of lower light coloured; feet brown.]

11. *Sauromarptis gaudichaudi*, Q. and G.

*Dacelo gaudichaudi*, Quoy and Gaim., Voy. Uran. Zool., p. 112, pl. xxv. (1824), Waigiou, Guebé (type examined); Sharpe, Mon. Alced., pl. cxvi. (1868–71).
*Sauromarptis gaudichaudi*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 306, sp. 35 (1877); Proc. Zool. Soc., 1878, p. 94.

[203, male; 204, female. Wokan. Eyes black; legs greenish, yellow tinge. Stomach contained insects and portions of leaves.]

The male has the tail blue, and the female has the tail chestnut.

12. *Sauromarptis tyro*, G. R. Gr.

*Dacelo tyro*, G. R. Gr., Proc. Zool. Soc., 1858, p. 171, pl. cxxx. Arrou (type examined); Sharpe, Mon. Alced., pl. cxvii. (1868–78).
*Sauromarptis tyro.*, Salvad., Ann. Mus. Civ. Gen., vol. x. p. 307, sp. 36 (1877); Proc. Zool. Soc., 1878, p. 94.

[No. 205. Wokan. Young male? Eyes black; legs greenish-yellow tinge. Stomach contained insects and portions of leaves.]

This bird differs from the adult in having the under parts entirely reddish, and in the blue of the wings inclining to greenish.

13. *Ægotheles wallacii*, G. R. Gr.

*Ægotheles wallacii*, G. R. Gr., Proc. Zool. Soc., 1859, p. 154, Dorey (type examined); Schleg. Ned. Tijdschar. Dierk., vol. iii. p. 340 (1866), Arrou; Salvad. Ann. Mus. Civ. Gen., vol. x. p. 310, sp. 7 (1877); Proc. Zool. Soc., 1878, p. 94.
*Caprimulgus brachyurus*, Rosenb., Nat. Tijdschr. Ned. Ind., vol. xxix. p. 143 (1867), Arrou (type examined).

[No. 259. Wanumbai. Female.]

I have compared this specimen with the type in the British Museum and with two other specimens from New Guinea, collected by D'Albertis and Bruijn's men. From all these it differs in the finer vermiculations, and in the somewhat smaller dimensions, and perhaps may belong to a different species; but we must see some more specimens from the Arrou Islands before we can decide the question.

The *Caprimulgus brachyurus*, Rosenb., is a young bird, with the tail incompletely developed.

14. *Macropteryx mystacea*, Less.

*Macropteryx mystacea*, Less.: Salvad., Proc. Zool. Soc., 1878, p. 95.

[No. 254. Wanumbai. Male. Eyes black.]

This bird has a brown spot on the ear-coverts.

15. *Hirundo javanica*, Sparrm.

*Hirundo frontalis*, Quoy and Gaim., Voy. Astrol. Zool., vol. i. p. 204, pl. xii. fig. 1 (1830), Dorey (type examined).
*Hirundo javanica*, Salvad., Proc. Zool. Soc., 1878, p. 95.

[No. 225. Dobbo. Female. Eyes black.]

16. *Hylochelidon nigricans*, Vieill.

*Hirundo nigricans*, Vieill, N. D., vol. xiv. p. 523 (1817), New Holland (type examined).
*Hylochelidon nigricans*, Salvad., Proc. Zool. Soc., 1878, p. 95.

[No. 226. Dobbo. Male. Eyes black. Shot by the Professor at the village of Dobbo.]

17. *Machærorhyncus xanthogenys*, G. R. Gr.

*Machærorhynchus xanthogenys*, G. R. Gr., Proc. Zool. Soc., 1858, p. 176, Arrou (type examined); Salvad., Atti R. Acc. Sc. Tor., vol. x. p. 375, sp. 2 (1875); Proc. Zool. Soc., 1878, p. 95.

[No. 234. Wokan. Male. Eyes and bill black; feet slate. Shot at Wokan.]

18. *Graucalus melanops*, Lath.

*Campephaga melanops*, var., G. R. Gr., Proc. Zool. Soc., 1861, p. 435.
*Graucalus melanops*, Salvad., Proc. Zool. Soc., 1878, p. 95.

[No. 228. Dobbo. Female. Eyes brown; stomach contained insects; legs and bill black. Shot by the Professor at the village of Dobbo.]

The specimen agrees entirely with black-faced Australian males, and with male birds collected by Signor D'Albertis at Yule Island (Ann. Mus. Civ. Gen., vol. vii. p. 820, 1875, sp. 41).

19. *Edoliosoma muelleri*, Salvad.

*Ceblepyris plumbea*, part., S. Müll. (*nec* Wagl.), Verh. Land. en Volkenk., p. 189. (1839–44), New Guinea only (type examined).
*Edoliosoma muelleri*, Salvad.: Ann. Mus. Civ. Gen., vol. vii. p. 928 (1875); Proc. Zool. Soc., 1878, p. 95.

[No. 260. Wanumbai. Male. No. 245. Female. Eyes hazel; bill black; legs dark with brownish tinge; stomach had insects. Shot on 20th. Dobbo.]

These specimens agree in every respect with New Guinea specimens. *Edoliosoma tenuirostre* (Jard. et Selby), from Australia, is scarcely different from the New Guinea bird; perhaps it is a little larger.

S. Müller, under the name of *Ceblepyris plumbea*, has united a specimen from

Utanata and a young bird from Timor; but this, according to me, belongs to a much lighter species, not yet named, of which I have seen adult specimens in the British Museum. With the same name of *Ceblepyris plumbea* there is in the Leyden Museum a specimen marked "Borneo;" it is a young bird exactly like that from Timor, and I think that the locality is wrong. On the evidence of this specimen, Hartlaub (Journ. f. Orn., 1865, p. 155) has asserted the existence of *Ceblepyris plumbea*, Müll., in Borneo.

20. *Dicruropsis assimilis*, G. R. Gr.

*Dicrurus assimilis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 129, Arrou (type examined).
*Chibia assimilis*, Sharpe, Cat. B. Brit. Mus., vol. iii. p. 239 (1877).
*Dicruropsis assimilis*, Salvad., Proc. Zool. Soc., 1878, p. 96.

[No. 214. Wokan. Female. Eyes dull red; feet and bill black. Stomach contained insects.]

21. *Colluricincla megarhyncha*, Q. and G.

*Muscicapa megarhyncha*, Quoy and Gaim., Voy. Astrol. Zool., vol. i. p. 172, pl. iii. fig. 1 (1830), Dorey (type examined).
*Napothera elœoides*, Müll., Mus. Lugd. (type examined).
*Myiolestes aruënsis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 180, Arrou (type examined).
*Pinarolestes megarhynchus*, Sharpe, Cat. B. Brit. Mus., vol. iii. p. 295 (1877).
*Colluricincla megarhyncha*, Salvad., Proc. Zool. Soc., 1878, p. 96.

[No. 240. Male. Eyes hazel; legs slate. Shot at Wanumbai.]

I quite agree with Mr Sharpe in uniting the Arrou bird with the New Guinea one.

22. *Rectes aruënsis*, Sharpe.

*Rectes dichrous*, G. R. Gr. (*nec.* Bp.), Proc. Zool. Soc., 1858, p. 179, Arrou.
*Rectes aruënsis*, Sharpe, Cat. B. Brit. Mus. vol. iii. p. 285 (1877), Arrou (type examined);[1] Salvad., Proc. Zool. Soc., 1878, p. 96.

[No. 238. Wanumbai. Female. Eyes dull red; feet slate-colour with a violet tinge; stomach contained land-shells and remains of insects.

No. 255. Wanumbai. Female. Eyes hazel.]

These specimens, both marked females, and a female collected by Beccari in the Arrou Islands agree in having the head blackish, the front-neck blackish tinged with reddish-brown, the uropygium and the upper tail-coverts blackish-brown, the tail blackish above, and decidedly reddish-brown underneath. These three specimens, all marked females, differ from two other specimens collected by Beccari, marked males. These have the

[1] The type of *Rectes dichrous ceramensis*, Meyer (Sitzb. Ak. Wien, vol. lxix. p. 208), which I have lately seen in the Museum of Vienna, is a specimen of *Rectes uropygialis*, Gray, and not of *Rectes aruënsis*, as Mr Sharpe suspected. The locality, Ceram, is, no doubt, wrong. *Rectes draschi*, Pelzeln, Verh. z.-b. Gesell. Wien, 1876, p. 218, is a female of *Edoliosoma schisticeps*, G. R. Gr. (*ex* Hombr. and Jacq., Voy. Pôle Sud, Atlas, Zool., pl. x. fig. 1, female).

head, the neck, the tail, and the upper tail-coverts jet-black; and the breast in one specimen is tinged with black more conspicuously than in the others. Ought we to believe that the plumage of the first three specimens, described by Sharpe as that of the young bird, is also the plumage of the adult female, or that by a strange combination all the three specimens marked females are really young ones?

23. *Cracticus cassicus*, Bodd.

*Cracticus cassicus*, Salvad., Proc. Zool. Soc., 1878, p. 97.

[No. 218. Wokan. Female. Eyes dark, deep blue; base of the mandibles light-coloured, with a tinge of blue, tips of mandibles black. Stomach with leaves and seeds.]

24. *Cyrtostomus frenatus*, S. Müll.

*Cyrtostomus frenatus*, S. Müll.: Salvad., Proc. Zool. Soc., 1878, p. 97.

[No. 222. Wokan. Male. Eyes black; bill and feet black.]

25. *Myzomela nigrita*, G. R. Gr.

*Myzomela nigrita*, G. R. Gr.: Proc. Zool. Soc., 1858, p. 173, Arrou (type examined); Salvad., Proc. Zool. Soc., 1878, p. 97; Forbes, Proc. Zool. Soc., 1879, p. 265.
*Myzomela erythrocephala*, Meyer (*nec* Gould), Sitzb. k. Ak. Wiss. zu Wien., vol. lxx. p. 204 (1874), ♀ and young ♂ (specimens examined).

[No. 232. Wokan. Male. Eyes hazel; bill and feet black. Stomach had insects.]

Gray describes the male as "entirely shining deep black," omitting to mention that it has the under wing-coverts and the inner edges of the remiges white.

26. *Xanthotis filigera*, Gould.

*Ptilotis filigera*, Gould, Proc. Zool. Soc., 1850, p. 278, pl. xxxiv., Cape York.
*Xanthotis filigera*, Salvad., Proc. Zool. Soc., 1878, p. 97.

[No. 261. Wanumbai. Male.]

This bird has the light spots on the nape scarcely visible. Two specimens from Utanata, collected by S. Müller, in the Museum of Leyden, belong to this species and not to the northern form *Xanthotis chrysotis* (Less.).

27. *Drymaœdus beccari*, Salvad.

*Drymaœdus beccari*, Salvad.: Ann. Mus. Civ. Gen., vol. vii. p. 965, sp. 52 (1875); Proc. Zool. Soc., 1878, p. 97.

[No. 257. Wanumbai. Male.]

This example agrees completely with the type from the Arfak Mountains. This is a new species for the Arrou Islands.

28. *Calornis metallica*, Temm.

*Calornis metallica*, Temm.: Salvad., Proc. Zool. Soc., 1878, p. 97.

[Nos. 215, 216, 217. Wokan. Males. Eyes coral red; bill and legs black. Small black seeds in the stomach of the adult males. The above were the most abundant birds we saw on the 17th September 1874.]

29. *Mino dumonti*, Less.

*Mino dumonti*, Salvad., Proc. Zool. Soc., 1878, p. 98.

[No. 250. Wanumbai. Male. Eyes yellow.

No. 233. Wanumbai. Female. Eyes yellow; legs and bill yellow. Stomach contained seeds.]

30. *Paradisea apoda*, Linn.

*Paradisea apoda*, Linn.: Salvad., Proc. Zool. Soc., 1878, p. 98.

[Nos. 248, 249. Males. Eyes yellow. No. 247. Female. Eyes brown. No. 202. Young male. Eyes pale yellow; legs light fawn-colour. The stomach was empty. This bird was shot by Mr Abbot; he saw two others at the same time, but noticed none of them with plumes. The Professor and Captain Nares saw a large flock, and, again, none of them were noticed with plumes. No other specimens were seen by the party. No. 246. Female. Eyes brown.]

Four specimens from Wanumbai, and one from Wokan.

1st. An adult male (No. 249), but not in full dress, wanting the long yellow feathers on the sides.

2d. A male (No. 248) not fully adult, having the two middle tail-feathers with very large webs, like the lateral ones, and longer than these, one about two inches, the other only one inch; they are of a lanceolate shape.

3d. An adult female (No. 247) with yellowish nape.

4th. A young male from Wokan (No. 202).

5th. A young female (No. 246). The two last are exactly alike in colour, but the male is larger than the female. Both have no yellow on the nape.

31. *Cicinnurus regius*, Linn.

*Cicinnurus regius*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 192, sp. 24 (1876); Sharpe, Cat. B. Brit. Mus., vol. iii. p. 171 (1877); Salvad., Proc. Zool. Soc., 1878, p. 98.

[No. 201. Male. Eyes dull red; legs a delicate sky-blue. The stomach contained

a few remains of insects. The bird was shot by Mr Abbot; two others were in company with it at the time. These were the only specimens seen either by Mr Abbot or any other of the party. They were not apparently very shy. A gun is said to have been fired close by just before they were observed. No. 241. Male, shot at Wokan. Eyes dull red; legs delicate sky-blue or cobalt blue. Nos. 242, 243. Males, shot at Wanumbia. Nos. 250, 251. Males. Eyes yellow. No. 252. Male (young). Eyes yellow.]

Seven specimens—one fully adult male (No. 201) from Wokan; and five adult males (Nos. 241, 242, 243, 250, 251), and a young male (No. 252) from Wanumbai.

32. *Manucodia atra*, Less.

*Manucodia atra*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 189, sp. 4 (1876); Sharpe, Cat. B. Brit. Mus., vol. iii. p. 183 (1877); Salvad., Proc. Zool. Soc., 1878, p. 98.

[Nos. 209, 210. Male and female. Eyes orange; legs black. The stomach contained fruit and seeds.]

The male is larger than the female.

33. *Æluræedus melanotis*, G. R. Gr.

*Pitlonorhynchus melanotis*, G. R. Gr., Proc. Zool. Soc., 1858, p. 181, Arrou (type examined).
*Æluræedus melanotis*, Gould, B. of New Guinea, part 1 (1875); Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 193, sp. 28 (1877); Proc. Zool. Soc., 1878, p. 99.

[No. 211. Eyes red; legs with a bluish tinge. Appears to be a young bird; could not make out the sex.]

Mr Gould has expressed some doubts about *Æluræedus arfakianus*, Meyer, being really different from this species; but the greater amount of black on the head and on the neck of *Æluræedus arfakianus*, the triangular shape of the light spots, with the acute angle turning downwards on the upper part of the breast, and the smaller dimensions, distinguish at once the New Guinea bird from its Arrouan relative.

34. *Ptilopus iozonus*, G. R. Gr.

*Ptilonopus* (!) *iozonus*, G. R. Gr., Proc. Zool. Soc., 1858, p. 186, Arrou (type examined).
*Ptilopus ionozonus*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 198, sp. 24 (1876).
*Ptilopus iozonus*, Salvad., Proc. Zool. Soc., 1878, p. 99; Elliot, Proc. Zool. Soc., 1878, p. 547.

[No. 289. Wanumbai. Female. Legs red; base of upper mandible red, tip yellow; lower green, with the tip lighter. Stomach empty.]

35. *Ptilopus coronulatus*, G. R. Gr.

*Ptilonopus coronulatus*, G. R. Gr., Proc. Zool. Soc., 1858, p. 185, pl. cxxxviii., Arrou (type examined).
*Ptilopus coronulatus*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 198, sp. 26 (1876); Proc. Zool. Soc., 1878, p. 99; Proc. Zool. Soc., 1879, p. 546.

[Nos. 220, 221. Wokan. Males. Eyes red; bill green; feet red (dull). Stomach empty.]

36. *Carpophaga zoëæ*, Less.

*Columba zoëæ*, Less., Voy. Coq. Zool. Atlas, pl. xxxix. (1826), vol. i. p. 705, part 2 (1828), Dorey (type examined).
*Carpophaga zoëæ*, Salvad., Ann. Mus. Civ. Gen., vol. ix. p. 201, sp. 47 (1876); Proc. Zool. Soc., 1878, p. 99.

[No. 236. Wanumbai. Male. Eyes white; legs red; beak black. Stomach contained seeds. Shot at Wanumbai.]

37. *Macropygia doreya*, Bp.

*Macropygia doreya*, Bp., Consp., vol. ii. p. 57 (1854), New Guinea (type examined); Salvad., Ann. Civ. Gen., vol. ix. p. 204, sp. 65 (1876); Proc. Zool. Soc., 1878, p. 99.
*Macropygia phasianella*, part., G. R. Gr. (*nec* Temm.), Proc. Zool. Soc., 1858, p. 187, Arrou Islands only; Wall., Ibis, 1865, p. 389, sp. 81 (*partim*).

[No. 254. Wokan. Female.]

38. *Megapodius duperreyi*, Less. & Garn.

*Megapodius duperreyi*, Less. and Garn., Bull. Sc. Nat., vol. viii. p. 113 (1826), Dorey (type examined); Less., Voy. Coq. Zool., vol. i. pp. 700, 703, part. 2, pl. xxxvi. (1826–28); Salvad., Proc. Zool. Soc., 1878, p. 100.
*Megapode reinwardt*, Temm., Pl. Col., liv. 37, genre *Megapode* (1823).
*Megapodius rubripes*, Temm. Pl. Col. 411 (25th October 1826[1]), Celebes! Amboyna!
*Megapodius reinwardtii* (*sic*), Temm. *apud* Wagl., Syst. Av. Gen. *Megapodius*, note (1827), descr. nulla.
*Megapodius reinwardtii*, Wagl., Syst. Av. Gen. *Megapodius*, Additamenta, sp. 4 (1827).
*Megapodius rufipes*, S. Müll., Verh. Land. en Volkenk. pp. 23, 109 (1839–44), Utanata.
*Megapodius*, sp., Wall. Ann. & Mag. Nat. Hist., (2) vol. xx. pp. 473, 477 (1857), Ki, Arrou.

[No. 230. Female. Eyes dull red; legs orange; bill horn-colour.]
A female (No. 230) from Wokan.

39. *Numenius uropygialis*, Gould.

*Numenius uropygialis*, Gould: Salvad., Proc. Zool. Soc., 1878, p. 100,

[No. 258. Wanumbai. Male.]

40. *Tringoides hypoleucus*, Linn.

*Tringoides hypoleucus*, Salvad., Proc. Zool. Soc., 1878, p. 100.

[No. 227. Dobbo. Female. Legs light green; bill dark green; eyes hazel. Stomach contained insects.]

[1] I doubt whether this date, given by Crotch (Ibis, 1868, p. 500), for the publication of the 69th livraison of Temminck's Planches Coloriées, is exact; my doubts rise from the fact that *Megapodius rubripes* is not mentioned by Wagler in his Systema Avium, published in 1827.

## V.—*On the Birds collected at Cape York, Australia, and on the Neighbouring Islands (Raine, Wednesday, and Booby Islands).* By W. A. Forbes, F.Z.S.

(Reprinted from the Proceedings of the Zoological Society for 1878.)

The collection of Birds made by H.M.S. Challenger at Cape York and in its neighbourhood, of which the following is an account, comprises 61 skins, referable to 37 species. As might have been expected, all, or nearly all, belong to well known Australian forms, one or two only being left uncertain for want of more materials and on account of the immature condition of the specimens. Most of the skins are in excellent condition; and their value is much increased by the notes in Mr Murray's journal as to the colour of the soft parts, &c. Besides Cape York, Raine Island (at the end of the Barrier Reef), Wednesday Island (in Torres Straits), and Booby Island (also in Torres Straits) were visited, and collections made. I copy the following extracts from Mr Murray's journal as regards the localities where Birds were obtained:—

"Raine Island, Barrier Reef, Australia. Ship landed two boats for nearly three hours. The following birds were taken" (several sea-birds, *Rallus pectoralis*, and *Strepsilas interpres*).

"Cape York, Somerset. Ship arrived on evening of 1st September 1874; left Cape York on September 8." (44 skins were obtained here).

"Wednesday Island, Torres Straits. Parties landed the same day (September 8). Most of the birds seen were the same as those shot about Cape York. The following two, however, have not been procured at Cape York; they were shot on shore (*Totanus incanus* and *Ægialites inornatus*). A great many flocks of Bee-eaters were noticed making passages between the islands."

"On 9th September 1874, a party landed on Booby Island, a very small island, with only a few shrubs on it. The following land birds were shot or brought on board; and in addition a Rail was seen, a *Megapodius*, and one other land bird." (The species obtained were *Todirhamphus sanctus*, *Merops ornatus*, *Zosterops luteus*, *Pachycephala*, sp., *Ptilopus superbus*, and *Synœcus cervinus*.)

In the following list I have, with a few exceptions, followed the arrangement and nomenclature of Mr Gould's Handbook to the Birds of Australia.

1. *Ninox boobook*, Lath.

*Ninox boobook*, Sharpe, Cat. of B., vol. ii. p. 168; Forbes, Proc. Zool. Soc., 1878, p. 121.
*Spiloglaux marmoratus*, Gould, Handb. B. Austr., vol. i. p. 73.

One male skin of this species from Cape York. No. 167. [Stomach contained insects.]

The specimen sent agrees generally with two skins in Mr Godman's collection from the same locality, and with Mr Gould's description of *Spiloglaux marmoratus*, which Mr Sharpe, in the second volume of his catalogue, treats as "the adult of the large form of *Ninox boobook*" (*l.c.*, p. 170).

2. *Podargus papuensis*, Quoy et Gaim.

*Podargus papuensis*, Quoy and Gaim. Voy. de l'Astrol. Ois., t. xiii.; Gould, B. of Austr. Suppl. pl.; *id.* Handb. B. Austr., vol. i. p. 91; Forbes, Proc. Zool. Soc., 1878, p. 121.

[No. 186, ♀. Eyes red; feet and bill light yellow. Stomach contained insects.] Cape York, one specimen.

3. *Merops ornatus*, Lath.

*Merops ornatus*, Gould, B. of Austr., vol., ii. pl. xvi.; *id.* Handb., vol. i. p. 117; Forbes, Proc. Zool., 1878, p. 121.

In all four specimens of this common Australian species. Two females from Booby Island (Nos. 199, 200), and a pair (♂ and ♀) from Cape York (Nos. 147 and 178). Of all the eyes are stated to be "red," and the feet and legs black, except the female from Cape York, which is described as having the legs "with violet tint." The three females differ considerably from one another in the length of the produced middle tail-feathers; in the male the produced part is thinner and at least twice as long as in the other sex.

4. *Todirhamphus sanctus*, Vig. and Hors.

*Todirhamphus sanctus*, Gould, Handb. B. Austr., vol. i. p. 128; Sharpe, Alced., pl. xci.; Forbes, Proc. Zool. Soc., 1870, p. 121.

One specimen from Booby Island. [No. 192, ♂. Eyes black; mandibles black, except base of lower one, which is whitish. Stomach had remains of a crab.]

5. *Halcyon macleayi*, Jard. and Selby.

*Halcyon macleayi*, Jard. and Selby, Ill. Orn., vol. iii., pl. ci.; Gould. B. of Austr., vol. ii. pl. xxiv.; Sharpe, Alc., pl. lxxviii.; Forbes, Proc. Zool. Soc., 1878, p. 122.
*Cyanalcyon macleayi*, Gould, Handb. B. Austral., vol. i. p. 133.

One male specimen from Cape York. [No. 161. Eyes, bill, and legs black. Stomach contained insects.]

6. *Artamus leucopygialis*, Gould.

*Artamus leucopygialis*, Gld. B. of Austr., vol. ii. pl. xxxiii.; *id.* Handb., vol. i. p. 154; Forbes, Proc. Zool. Soc., 1878, p. 122.

One specimen from Cape York. [No. 177, ♂. Bill blue tipped with black, feet black. Stomach contained insects.]

7. *Graucalus hypoleucus*, Gould.

*Graucalus hypoleucus*, Gould, B. of Austr., vol. ii., pl. lvii.; *id.* Handb., vol. i. p. 196; Forbes, Proc. Zool. Soc., 1878, p. 122.

One skin of this species from Cape York. [No. 151, ♀. Legs, bill, and eyes black. Stomach contained insects.]

8. *Pachycephala*, sp. inc.

*Pachycephala*, sp. inc.: Forbes, Proc. Zool. Soc., 1878, p. 122.

[No. 196, ♂. *Pachycephala.* Eyes brown; bill and legs horn-colour. Stomach had insects.]

A single skin of a *Pachycephala* from Booby Island, immature, still retaining some of the rufous feathers characteristic of immaturity in its wings. It is certainly one of the species which, when adult, are yellow beneath, the under tail-coverts being bright gamboge-yellow. The species of this group are so hard to determine, unless males and in adult plumage, that it seems better to leave this bird, although not exactly like any *Pachycephala* I have been able to examine in the British Museum or in Mr Godman's collection, without a name for the present, more particularly as Mr Sharpe is, I believe, now working at this group for the next volume of his catalogue.

9. *Pinarolestes rufigaster*, Gould.

*Colluricincla rufigaster*, Gould, B. of Austr., vol. i. p. 37; *id.* Handb. B. of Austr., vol. i. p. 226.
*Pinarolestes rufigaster*, Sharpe, Cat. of B., vol. iii. p. 296; Forbes, Proc. Zool. Soc., 1878, p. 122.

[No. 170, ♀. Shrike.]

One specimen, from Cape York, of this difficult genus. Mr Gould, to whom I showed the specimen, was inclined to indentify it with his *Colluricincla parvissima*[1] (Ann. and Mag. Nat. Hist., ser. 4., vol. x. p. 114), and has kindly lent me the type of that species (which Mr Sharpe, *l. c.*, p. 297, treats as the young of *Pinarolestes rufigaster*) for comparison. I find, however, that the Cape York bird has a distinctly shorter wing, a stronger and more arched bill, and is less rufous on the under side. Mr Sharpe, who has recently worked up this group for his catalogue, has examined this specimen, and refers it to *Pinarolestes rufigaster*.

10. *Manucodia gouldi*, Gray.

*Manucodia gouldi*, Gould, Handb. B. Austr., vol. i. p. 236; Sharpe, Cat. of B., vol. iii. p. 181; Forbes, Proc. Zool. Soc., 1878, p. 123.
*Manucodia keraudreni*, Gould, B. Austr., Suppl., pl. ix.

Two female specimens. [No. 152. Bower-bird. Eyes orange; bill and legs black.

[1] Count Salvadori suggests that this really = *P. megarhynchus* of New Guinea.

Stomach contained small seeds. For curious loop in the windpipe see body. This bird was shot on the island opposite Somerset by Moseley.] The colours of the soft parts and contents of the stomach are the same in the other specimen.

The two skins sent agree well with Mr Sharpe's description and differ from Mr Elliot's figure of the New Guinea species (*Manucodia keraudreni*) in the points noticed in Gray's original description of the species. The curious conformation of the trachea in *Manucodia keraudreni* has long been known, having been originally described by Lesson. Beccari (Ibis, 1876, p. 252) says he thinks it probable that this is a peculiarity of the male sex. Mr Murray's notes, however, would seem to contradict this view, unless, as is hardly likely, two species otherwise so nearly allied should differ in this peculiarity.

11. *Ptilorhis alberti*, Elliot

*Ptiloris alberti*, Ell., Proc. Zool. Soc., 1871, p. 583; *id.* Mon. Parad., pl. xxiv.; Sharpe, Cat. of B., vol. iii. p. 156; Forbes, Proc. Zool. Soc., 1878, p. 123.
*Ptiloris magnificus*, Gould, B. Austr. Supp., pl. li.
*Craspedophora magnifica*, *id.* Handb., vol. i. p. 595.

Six skins of this Rifle-bird from Cape York, four of which are adult males in full plumage, and one a female. Another, marked ♀, is either a young male coming into full plumage, or more probably an aged female assuming male plumage, as some of the feathers on the top of the head show traces of a metallic blue colour, as also does the shoulder, whilst more or fewer of the primaries on each side have acquired the black colour characteristic of the male. Of Nos. 164 and 165 it is noted in Mr Murray's journal:—"Males. Eyes, bill, and legs black; soles of the feet yellow. The stomach contained a red fruit, with a large stone about the size of a pea. Some parts of insects in 165." Of No. 184, "Female. Eyes black. Stomach contained ants and grubs." Besides the specimens sent, several others seem to have been procured. An interesting account of the shooting of these specimens will be found in Lord George Campbell's Log Letters from the Challenger, p. 185.

12. *Mimeta viridis*, Lath.

*Mimeta viridis*, Gould, Handb. B. Austr., vol. i. p. 462; Forbes, Proc. Zool. Soc., 1878, p. 123.
*Oriolus viridis*, Gould, B. Austr., vol. iv., pl. xiii.; Sharpe, Cat. of B., vol. iii. p. 212.

A young male from Cape York, agreeing generally with Mr Sharpe's description (*l.c.*) of the young bird. [No. 169, ♂. Thrush.]

13. *Mimeta flavocinctus*, King.

*Mimeta flavocincta*, Gould, Handb. B. Austr., vol. i. p. 466; Forbes, Proc. Zool. Soc., 1878, p. 123.
*Oriolus flavocinctus*, Gould, B. of Austr., vol. iv. pl. xiv.
*Oriolus flavicinctus*, Sharpe, Cat. of B., vol. iii. p. 206.

An adult male from Cape York, agreeing with skins in Mr Godman's collection, collected by Cockerell. [No. 189, ♂. Shrike. Eyes red; bill red; feet bluish.]

14. *Sphecotheres flaviventris*, Gould.

*Sphecotheres flaviventris*, Gould, B. of Austr. Suppl., pl. xxxvii.; *id.* Handb. B. Austr., vol. i. p. 468; Sharpe, Cat. of B., vol. iii. p. 225; Forbes, Proc. Zool. Soc., 1878, p. 124.

Three specimens from Cape York, of which two are males in full plumage, agreeing with specimens in Mr Godman's collection. "Nos. 172, 173. Eyes black; feet flesh; bill black." The third specimen is marked "female" ("No. 174, ♀. Eyes black; bill horn; legs brownish. Stomach contained insects and seeds"), but, as there are traces of yellow on the breast, is more probably a young male assuming the adult plumage. The orbits in this bird (in the skin) are dark brownish-black, not yellow, though this is probably accidental. In other points, too, particularly in the plainly striated under tail-coverts, and the colouring of the upper surface of the head, the specimen hardly agrees with Mr Gould's description of the female *Sphecotheres flaviventris*. Mr Gould, to whom I have shown it, would give no decided opinion on it; but Mr Sharpe has examined it, and pronounces it to be of this species.

15. *Ptilotis chrysotis*, Lewin.

*Ptilotis chrysotis*, Gould, B. of Austr., vol. iv., pl. xxxii.; Forbes, Proc. Zool. Soc., 1878, p. 124.
*Ptilotis lewini*, Swains.: Gould, Handb. B. Austr., vol. i. p. 503.

Three skins of this common Australian species, which is not recorded from North Australia in the Handbook—two from Cape York, one from Cape York Island. [No. 150, ♀. Eyes brown; legs slate; bill black. Stomach contained insects. No. 157, ♂. Eyes brown; bill black; legs blue; different from 156 (*Ptilotis filigera*). Stomach contained insects, same as 156.]

16. *Ptilotis filigera*, Gould.

*Ptilotis filigera*, Gould, B. of Austr. Suppl., pl. xlii.; *id.* Handb. B. Austr., vol. i. p. 522; Forbes, Proc. Zool. Soc., 1878, p. 124.

A single example, from Cape York Island, of this distinct Honey-eater, originally described by Mr Gould from this district. [No. 156, ♂. Eyes brown; bill black; legs bluish. Stomach contained insects and small brown bodies like seeds.]

17. *Philemon buceroides*, Swainson.

*Tropidorhynchus buceroides*, Gould, B. of Austr., Suppl., pl. xliv.; *id.* Handb. B. Austr., vol. i. p. 547; Forbes, Proc. Zool. Soc., 1878, p. 124.

One specimen from Cape York, agreeing with specimens in Mr Godman's collection. [No. 160, ♀. Leatherhead. Eyes dark red; bill and skin about the head black. Stomach contained beetles and other insects.]

18. *Myzomela obscura*, Gould.

*Myzomela obscura*, Gould, B. of Austr., vol. iv., pl. lxvii.; *id.* Handb. B. Austr., vol. i. p. 559; Forbes, Proc. Zool. Soc., 1878, p. 125.

A single skin from Cape York. [No. 159, ♂. Eyes brown.][1]

19. *Dicæum hirundinaceum*, Shaw.

*Dicæum hirundinaceum*, Gould, B. of Austr., vol. ii., pl. xxxiv.; *id.* Handb. B. Austr., vol. i. p. 581; Forbes, Proc. Zool. Soc., 1878, p. 125.

A single specimen in full plumage, from Cape York. [No. 149, ♂. Eyes black; legs and bill black. Stomach contained green fruit.]

20. *Nectarinia frenata*, Müll.

*Nectarinia australis*, Gould, B. of Austr., Suppl., pl. xlv.; *id.* Handb. B. Austr., vol. i. p. 584; Forbes, Proc. Zool. Soc., 1878, p. 125.

Three specimens from Cape York Island (two males in full plumage, and a female) of this Sunbird, which Mr Sclater has recently shown to be the *Nectarinia frenata* of Müller (see Proc. Zool. Soc., 1877, p. 104). [No. 153, ♂; 154, ♂; 155, ♀. Eyes brown; legs and bill black. Stomach contained small insects.]

21. *Zosterops luteus*, Gould.

*Zosterops luteus*, Gould, B. of Austr., vol. iv., pl. lxxxiii.; *id.* Handb. B. Austr., vol. i. p. 590; Forbes, Proc. Zool. Soc., 1878, p. 125.

One specimen from Booby Island [No. 197, ♀. Eyes brown; feet and bill with a bluish tinge. Stomach had small seeds], which agrees with a specimen of this species collected by Macgillivray, kindly lent to me by Mr Gould for comparison.

[1] Mr Gould says "bright red."

22. *Cacomantis flabelliformis*, Lath.

*Cacomantis flabelliformis*, Gould, Handb. B. Austr., vol. i. p. 618 ; Forbes, Proc. Zool. Soc., 1878, p. 125.
*Cuculus cinereaceus*, Gould, B. of Austr., vol. i., pl. lxxxvi.

A female, from Cape York, of this Cuckoo, agreeing with specimens in Mr Godman's collection, except in having the breast and underparts much duller rufous, and faintly freckled and banded with dusky—indications, probably, of a young bird. [No. 146, ♀. Cuckoo. Eyes brown ; legs yellow on hind aspect ; brown on front ; bill brown. Contained insects in stomach.]

23. *Centropus phasianus*, Lath.

*Centropus phasianus*, Gould, B. of Austr., vol. iv., pl. xcii. ; *id.* Handb. B. Austr., vol. i. p. 634 ; Forbes, Proc. Zool. Soc., 1878, p. 125.

A female from Cape York. [No. 163. Legs bluish ; bill horn. Stomach contained insects.]

24. *Microglossus aterrimus*, Gm.

*Microglossum aterrimum*, Gould, B. of Austr., Suppl., pl. lxi.; *id.* Handb. B. Austr., vol. ii. p. 27 ; Finsch., Papag., vol. i. p. 370 ; Forbes, Proc. Zool. Soc., 1878, p. 125.

A pair of specimens from Cape York. [No. 185, ♂. Eyes black. Stomach contained seeds and fruit. No. 188, ♂. Stomach contained fruit, same as 185.] The male has the beak larger, and feathers of the crest more developed than the female.

25. *Trichoglossus swainsoni*, Gould.

*Trichoglossus swainsoni*, Gould, B. of Austr., vol. v., pl. xxviii. ; Forbes, Proc. Zool. Soc., 1878, p. 126.
*Trichoglossus multicolor*, Gould, Handb. B. Austr., vol. ii. p. 93.

A pair of this well-known species from Cape York. [No. 145, ♂. Legs and eyes grey ; bill orange, with a darker tinge. Green fruit. No. 166, ♂. Same as 145.]

This species of *Trichoglossus* is not recorded from the north part of Australia in Mr Gould's Handbook, though, as noticed by Finsch (Papag., vol. ii. pp. 822, 824), it extends northwards as far as Cape York.

26. *Ptilopus superbus*, Temm.

*Ptilonopus superbus*, Gould, B. of Austr., vol. v., pl. lvii.
*Lamprotreron superbus*, *id.* Handb. B. Austr., vol. ii. p. 108.
*Ptilopus superbus*, Forbes, Proc. Zool. Soc., 1878, p. 126.

Two males and a female, from Booby Island, of this Fruit-pigeon. [No. 193, ♀ ; 194, ♂. Eyes yellow ; bills greenish ; feet red. Stomachs had nothing in them." No. 198, ♂. Dove ; same as 194. Stomach contained nothing.]

27. *Carpophaga assimilis*, Gould.

*Carpophaga assimilis*, Gould, B. Austr., Suppl., pl. lxvii.; Forbes, Proc. Zool. Soc., p. 126.
*Megaloprepia assimilis*, Gould, Handb. B. Austr., vol. ii. p. 111.

A male from Cape York, agreeing in coloration and size with specimens in Mr Godman's collection. [No. 180. Feet green; eyes red; bill greenish-yellow; red at base and about nostrils.]

28. *Geopelia humeralis*, Temm.

*Geopelia humeralis*, Gould, B. of Austr., vol. v., pl. lxxii.; Forbes, Proc. Zool. Soc., 1878, p. 126.
*Erythrauchæna humeralis*, *id.* Handb. B. Austr., vol. ii. p. 142.

One from Cape York. [No. 171, ♂. Eyes red; feet purple; bill black. Stomach contained fruit.]

29. *Geopelia tranquilla*, Gould.

*Geopelia tranquilla*, Gould, B. Austr., vol. v., pl. lxxiii.; *id.* Handb. B. Austr., vol. ii. p. 144; Forbes, Proc. Zool. Soc., 1878, p. 126.

A single specimen, apparently immature, of this little ground-dove from Cape York. [No. 148, ♀. Eyes white; cere blue; bill slate; legs pale flesh-colour. Stomach contained small seeds.]

30. *Megapodius tumulus*, Gould.

*Megapodius tumulus*, Gould, B. of Austr., vol. v., pl. lxxix.; *id.* Handb. B. Austr., vol. ii. p. 167; Forbes, Proc. Zool. Soc., 1878, p. 126.

A single specimen, unsexed, of a Megapode, from Cape York, agreeing with Mr Gould's description of *Megapodius tumulus*. [No. 168.]

31. *Talegalla lathami*, Gray.

*Talegalla lathami*, Gould, B. of Austr., vol. v., pl. lxxvii.; Forbes, Proc. Zool. Soc., 1878, p. 127.

A male from Cape York, a district from which it is not recorded by Mr Gould. [No. 187. Eyes yellow;[1] head red. Stomach contained seeds.]

32. *Turnix melanota*, Gould.

*Turnix melanotus*, Gould, Hand. B. Austr., vol. ii. p. 182; Forbes, Proc. Zool. Soc., 1878, p. 127.
*Hemipodius melanotus*, B. of Austr., vol. v. pl. lxxxiv.

Two females of this species, originally described by Mr Gould, from Moreton Bay,

[1] "Brown," according to Mr Gould; his was probably a younger bird.

agreeing perfectly with the description in the Handbook. [No. 176. Cape York, Albany Island. Eyes white; feet yellow; bill yellow and black. Stomach contained insects. No. 195. Booby Island. Eyes white; legs yellow; base of bill yellow, tip black. Stomach contained small round seeds.]

33. *Synœcus cervinus*, Gould.

*Synœcus cervinus*, Gould, Hand. B. Austr., vol. ii. p. 195; Forbes, Proc. Zool. Soc., 1878, p. 127.

A Quail, from Cape York Island, which agrees with specimens of this species in Mr Gould's collection. [No. 175, ♂. Eyes brown; feet yellow; (bill ?) bluish-black.]

34. *Ægialites inornatus*, Gould.

*Hiaticula inornata*, Gould, B. of Austr., vol. vi. pl. xix.
*Ochthodromus inornatus*, Gould, Handb. B. Austr., vol. ii. p. 237.
*Ægialites inornatus*, Forbes, Proc. Zool. Soc., 1878, p. 127.

A female, from Wednesday Island, agreeing with specimens in Mr Godman's collection, but with the markings on the face and the pectoral band somewhat darker. [No. 191. Wednesday Island. Eyes, legs, and bill black.]

35. *Totanus incanus*, Gm.

*Totanus pulverulentus*, Müll., Natuurk. Land. en Volkenk., p. 152.
*Totanus griseopygius*, Gould, B. of Austr., vol. vi. pl. xxxviii.
*Gambetta pulverulentus*, Gould, Handb. B. Austr., vol. ii. p. 268.
*Totanus incanus*, Forbes, Proc. Zool. Soc., 1878, p. 127.

One from Wednesday Island. [No. 190, ♀ Sandpiper. Legs yellow, bill blackish, eyes black. Stomach contained remains of Crustacea.]

36. *Strepsilas interpres*, L.

*Strepsilas interpres*, Forbes, Proc. Zool. Soc., 1878, p. 127.

Three specimens from Raine Island. [No. 128, ♂. Eyes brown; feet light red, with black claws; bill black. Stomach contained small calcareous particles. No. 129, ♀. Same as 128. No. 142, ♀. Same as 128.]

37. *Rallus pectoralis*, Gould.

*Rallus pectoralis*, Gould, B. Austr., vol. vi., pl. lxxvi.; Forbes, Proc. Zool. Soc., 1878, p. 127.

Two males and a young female, from Raine Island, of this well-known species. The young bird, No. 130, resembles the old one generally in coloration, but has all the colours duller, the transverse barring of the lower surface much less conspicuous and altogether

wanting on the breast, the white spots of the scapularies absent, those on the wing-coverts smaller, and those on the tertiaries also smaller, and tinged with rufous; the primaries also are less conspicuously banded with rufous.

[Nos. 126, 127, males. Eyes red; upper mandible dark, the lower with a slight red tinge; feet light brown. Stomach contained beetles, egg-shells, and small calcareous particles.]

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## VI.—*On the Birds collected in the Sandwich Islands.* By P. L. Sclater, M.A., Ph.D., F.R.S.

(Plates XXI., XXII.)

(Reprinted from the Proceedings of the Zoological Society, 1878. With additions by the author.)

The Challenger arrived in Hilo Bay, Owhyhee, on the 14th of August 1875, and left on the 19th of the same month.

The skins of birds collected were twenty-four in number, belonging to thirteen species. They were all obtained "within eight miles of the town."

The collection, although small, and containing nothing absolutely new except a single *Anas*, is of interest, as it enables us to record the actual island of the Sandwich group upon which the species contained in it were found, and as it includes an example of the little-known *Buteo solitarius* of Peale.

The most complete account of the avifauna of the Hawaiian groups of islands is that given by Mr Sanford B. Dole in 1869 in the Proceedings of the Boston Society of Natural History.[1] On this article I commented at some length in a paper published in the Ibis for 1871.[2] Mr Dole has since published a revised List of the Birds of the Hawaiian Islands in the Hawaiian Annual,[3] and M. Oustalet has lately described a peculiar new form from the same locality.[4] Finally, I have written some further remarks on the same subject in the Ibis of 1879.[5]

From these different sources we are now acquainted with about fifty species as inhabitants of these islands, of which about one-half are peculiar to the group. But there remain, no doubt, many other species to be discovered in the interior. In the interests of science it is highly desirable that steps should be taken for the better

[1] Synopsis of the Birds hitherto described from the Hawaiian Islands. By S. B. Dole, Proc. Boston. Soc., N. H., vol. xii. p. 294.

[2] Remarks on the Avifauna of the Sandwich Islands. By P. L. Sclater, Ibis, 1871, p. 356.

[3] See Ibis, 1880, p. 248, for a notice of this publication.

[4] *Loxioïdes bailleui: vide* Bull. Soc. Phil. de Paris, 7me ser., tom. i. p. 99.

[5] On Recent Additions to our Knowledge of the Avifauna of the Sandwich Islands. By P. L. Sclater, Ibis, 1878, p. 89.

exploration of those islands, as Dr Finsch, who has lately visited the group, tells us that the native flora and fauna are fast perishing under the pressure of introduced species.[1]

The collection made by the Naturalists of the Challenger Expedition contains examples of the following species :—

1. *Chasiempis sandvicensis*, Gm.

*Sandwich flycatcher*, Lath., Syn., vol ii. p. 343, *unde.*
*Muscicapa sandvicensis*, Gm., S. N., vol. i. p. 945.
*Chasiempis sandvicensis*, Cab., Wiegm, Arch., 1874, vol. i. p. 208; Scl., Proc. Zool. Soc., 1878, p. 346.
*Cnipolegus*, sp. 1238, Scl., Cat. A. B., p. 203; *vide* Proc. Zool. Soc., 1878, p. 555.

[No. 528. ♀. } Hilo, Owhyhee.
No. 529. ♀. }
Flycatcher: eyes black. Stomachs contained insects.]

2. *Phœornis obscura*, Gm.

*Dusky flycatcher*, Lath., Syn., vol. ii., p. 344, pt. 1, *unde.*
*Muscicapa obscura*, Gm., S. N., vol. i. p. 945.
*Tœnioptera obscura*, Cassin, B. U. S. Expl. Exp., Atlas, pl. ix. fig. 3.
*Phœrnis obscura*, Scl., Ibis, 1859, p. 327, et 1871, p. 360; Proc. Zool. Soc., 1878, p. 347.

[No. 534. ♂. ⎫
No. 535. ♀. ⎪
No. 536. ,, ⎬ Hilo, Owhyhee.
No. 537. ,, ⎭
Eyes brown; bill and feet black.]

3. *Mohoa nobilis*, Merr.

*Gracula nobilis*, Merrem, Av. Descr. et Ic., p. 8, pl. ii.
*Mohoa nobilis*, Cass., Pr. Ac. Sc. Phil., vol. vii. p. 440; Scl., Proc. Zool. Soc., 1878, p. 374.
*Yellow-tufted bee-eater*, Lath., Syn., vol. i. p. 683, *unde.*
*Merops niger*, Gm., S. N., vol. i. p. 465.

[No. 524. Male. Hilo. Eyes black. Stomach contained fruit and insects.]

4. *Psittirostra psittacea*, Gm.

*Parrot-billed grosbeak*, Lath., Syn., vol. ii. p. 108, pl. lxii., *unde.*
*Loxia psittacea*, Gm., S. N., vol. i. p. 844.
*Psittirostra psittacea*, Sw., Class B., vol. ii. p. 295; Scl., Proc. Zool. Soc., 1878, p. 347.

[No. 538. Male. } Hilo.
No. 545. Male. }

[1] See his Ornithological Letter from the Pacific, Ibis, 1880, p. 75.

Eyes red. Stomach contained fruit.]

As I have already stated (Ibis, 1871, p. 360), this bird has, in my opinion, no relationship to the Fringillidæ, but is merely an exaggerated form of the same type as *Hemignathus* and its allied genera.

5. *Drepanis coccinea*, Merr.

*Mellisuga coccinea*, Merrem, Av. Descr. et Ic., p. 14, pl. iv., 1786.
*Drepanis coccinea*, Cassin, Zool. U. S. Expl. Exp., p. 177; Scl., Proc. Zool. Soc., p. 347.

[No. 521. Female adult.
No. 522. Young female. } Hilo.
No. 523. „ „
Eyes red; bill and legs orange. Stomach contained insects and seeds.]

6. *Drepanis sanguinea*, Gm.

*Certhia sanguinea*, Gm., S. N., vol. i. p. 479.
*Drepanis sanguinea*, Bp., Consp., vol. i. p. 404; Scl., Proc. Zool. Soc., 1878, p. 347.

[No. 530. Female. Hilo.]

7. *Drepanis flava*, Bloxham.

*Drepanis flava*, Blox., Voy. Blonde, p. 249; Dole, Proc. Boston Soc., N. H., vol. xii. p. 298; Scl., Proc. Zool. Soc., 1878, p. 348.

[No. 525. Male.
No. 526. Male.
No. 527. Female. } Hilo, Owhyhee.
No. 533. Female.
Eyes black. Stomachs had seeds and insects.]

The females are much less yellowish than the males, especially below.

8. *Munia nisoria*, Temm..

*Munia nisoria*, Walden, Trans. Zool. Soc., vol. viii. p. 73; Scl., Proc. Zool. Soc., 1878, p. 348.

[No. 543. Male. Sparrow, introduced; native who shot it said he had never seen one before.]

An imperfect skin of this species (or of the nearly allied *M. punctularia*), no doubt introduced.

Professor Baird a short time ago sent me a skin of a young or female of another Eastern Finch from the Sandwich Islands (probably *Munia malabarica*) for determination; also without doubt introduced.

9. *Asio brachyotus*, Forster.

*Strix sandwichensis*, Bloxam, Voy. Blonde, p. 250.
*Asio galapagoensis*, Cassin, Mamm. and Orn., U.S. Expl. Exp., p. 207.
*Asio acciptrinus*, Sharpe, Cat. B., vol. ii. p. 234.
*Otus brachyotus*, Scl., Proc. Zool. Soc., 1878, p. 348.

[No. 544. Male. Eyes yellow. Brought on board alive.]

10. *Buteo solitarius*, Peale (Pl. XXI.).

*Buteo solitarius*, Peale, Zool. U. S. Expl. Exp., Birds, p. 62 (1848); Scl., Proc. Zool. Soc., 1878, p. 348.
*Pandion solitarius*, Cassin, Mamm. & Orn. U. S. Expl. Exp., p. 97, Atlas, pl. iv.
*Polioaëtus solitarius*, Sharpe, Cat. B., vol. i. p. 452.

[No. 540. Female. Eyes brown; cere and legs yellow; bill black.]

Mr J. H. Gurney has kindly examined this interesting bird for me (of which two specimens were obtained, but one of them was subsequently lost), and supplied me with the following notes:—

"The female Buzzard brought from Owhyhee by the Challenger Expedition (No. 540 in that collection) appears to be of the same species, though in a different stage of plumage, as the previously unique specimen from the same island, which is preserved in the Museum of the Academy of Natural Sciences at Philadelphia, and which was described by Peale, in the first edition of the Zoology of the United States Exploring Expedition, published in 1848, under the name of *Buteo solitarius*.

"In the subsequent edition of this work, published in 1858, and edited by the late Mr Cassin, the generic name of *Buteo*, as applied to this species, was dropped, and that of *Pandion* substituted, with the following remark:—'This bird is strictly a member of a sub-genus of the generic group *Pandion* designated *Polioaëtus* by Dr Kaup.' (*Vide op. cit.*, p. 98.)

"Mr Ridgway, on the contrary, after an examination of the type specimen, wrote to me that he considered it a 'Buteonine form differing from the true *Buteones* only . . . . in the system of coloration, which reminds us somewhat of *Milvago chimachima*.'

"In the specimen brought home in the Challenger there is much less resemblance to the coloration of *Milvago chimachima*, and nothing, in my opinion, to justify the removal of this species from the genus *Buteo*.

"The following is a comparison of the measurements of the Challenger example with those of the type specimen as given by Mr Cassin in the work to which I have referred:—

| | Type specimen (sex unknown). | Challenger specimen (Female). |
|---|---|---|
| | Inches. | Inches. |
| Total length of skin, | 17 (above) | 17·7 |
| Wing, | 12 | 12 |
| Tail, | 7·5 | 7·2 |
| Bill from gape, | 1·5 | 1·5 |
| Tarsus, | 2·75 | 2·8 |
| Hind toe and claw, | 1·75 | 2·2 |
| Middle toe s. u., | ... | 1·7 |
| Claw of ditto, | ... | 0·8 |
| Culmen (exclusive of cere), | ... | 1·1 |
| Cere, | ... | 0·4 |

"Mr Cassin describes the type specimen as having 'the third, fourth, and fifth quills longest and nearly equal,' which agrees with the Challenger specimen, as does his description under the head of 'form' generally; but I think that, in speaking of the toes as having 'their under surfaces strongly corrugated or pustulated, claw very large, long, and curved,' he uses rather stronger language than is strictly applicable to the Challenger specimen, though in this the under surface of the feet is certainly somewhat corrugated and roughened, and the claws are slightly longer than in *Buteo vulgaris* or in *Buteo desertorum*.

"As regards the difference of coloration in the two specimens, Mr Cassin describes the type as having the 'head and entire underparts and upper tail-coverts yellowish-white, all the feathers being pure white at their bases and widely terminated with pale yellowish, more distinct on the breast and tibiæ.'

"In the Challenger bird the upper part of the head is dark wood-brown like the mantle, except that some of the feathers, especially on the crown and forehead, are partially edged with yellowish white; on the sides of the head these white edgings are more conspicuous; the throat is white; the breast, abdomen, under tail-coverts, flanks, and wing-linings are white, slightly tinged with buff especially on the tibiæ, and more or less mingled with wood-brown throughout, except on the lower abdomen and tibiæ, the brown predominating over the buffy-white on the flanks, and almost entirely covering the sides of the breast.

"Mr Cassin further describes the type specimen as having the 'occiput and neck behind with oblong longitudinal spots of umber-brown, which is the colour also of all the upper surface of the body, wings, and tail; shafts of quills reddish-chestnut on their upper surface, white beneath; inner webs of quills widely edged with white; tail beneath silky-white tinged with yellowish.'

"The Challenger specimen agrees with this portion of Mr Cassin's description, with

the following exceptions, viz. :—the occiput and hinder part of the neck are white-coloured and of the same hue as the mantle; the upper surface of the shafts of the quills is brown, but without any 'reddish-chestnut' tint; the upper surface of the tail is brown, with transverse bars of a darker brown; on the middle pair of rectrices there are eleven in number, the lowest bar being subterminal; on all the rectrices the edge of the outer web and the tip are of a darker brown than the remainder of the feather, but beyond the dark tip there is at the extreme end of the feather a small central spot of white, which is more conspicuous on a new rectrix only partially grown than in the older feathers, from some of which it has been worn off by use; the inner webs of the lateral rectrices are also more or less mottled with white towards the edge. The dark transverse bars are indistinctly apparent on the under surface of the tail.

"The figure of the type specimen (U. S. Exploring Expedition, pl. iv.) agrees with the description given by Mr Cassin, and also shows a larger bare space behind the eye than exists in the Challenger specimen; but, notwithstanding this difference and those of coloration to which I have alluded, I think that the coincidence of size and form marks the two specimens as belonging to the same species, and that the example obtained by the Challenger Expedition must be considered as a specimen of *Buteo solitarius* of Peale."

11. *Anas wyvilliana*, Scl. (Pl. XXII.)

*Anas boschas*, Dole, Pr. Boston S. N. H., vol. xii. p. 305; Finsch et Hartl., Orn. C. P., p. 39 (?)
*Anas wyvilliana*, Scl., Proc. Zool Soc., 1878, p. 350.

[No. 541. Male.
No. 542. Male. } Eyes brown; legs and feet orange.]

Supra nigra, plumis fusco limbatis; pileo nigro, fusco minute punctato; subtus pallide fusca, in gutture et pectore magis rufescens, in ventre magis ochracea, plumis nigro punctatis et maculatis; alis extus brunnescenti-cinereis; speculo amplo purpureo, margine supra et infra albo inde nigro ornato; axillaribus albis; rostro superiore nigro, inferiore carneo; pedibus aurantiacis. Long. tota 15·0, alæ 9·3, caudæ 3·0, rostri a rictu 2·0, ejusd. lat. sub naribus 0·7, tarsi 1·5.

*Hab.*—Inss. Sandwich, maris Pacifici.

This Duck belongs to the section of true *Anas* which embraces *Anas obscura* of North America, *Anas superciliosa* of Australia, and other species, and in which both sexes somewhat resemble the female of *Anas boschas*. The head is dark, finely pointed with brown, and bears no traces of a superciliary stripe; the speculum is shining purple with a black border above and below; beyond the black border below the coverts terminate in a broad margin of pure white; above the upper black border, which is formed by the ends of the small coverts, there is a narrow ashy-white margin.

The description and figure (Pl. XXII.) are taken from specimen 541; the other (542) is apparently a young bird, and is rather smaller in its dimensions.

12. *Fulica alai*, Peale.

*Fulica alai*, Peale, Zool. U. S. Expl. Exp., Birds, p. 224; Cassin, Mamm. & Orn. U. S. Expl. Exp., p. 306, Atlas, pl. xxxvi; Scl., Proc. Zool. Soc., 1878, p. 351.

[No. 531. Male. Eyes red; bill flesh-coloured with a yellowish tinge; feet and legs pale slate colour.]

13. *Totanus incanus*, Gm.

*Totanus incanus*, Scl., Proc. Zool. Soc., 1878, p. 351.

[No. 532. Female. Eyes hazel; bill brown; legs yellow.]

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## VII.—*On the Birds collected in Antarctic America.* By P. L. Sclater, M.A., Ph.D., F.R.S., and Osbert Salvin, M.A., F.R.S.

(Reprinted from the Proceedings of the Zoological Society for 1878. With additions by P. L. Sclater, F.R.S.)

In this Report the birds collected at the island of Juan Fernandez, at various points during the subsequent passage along the coast of Patagonia, and at the Falkland Islands are noticed.

The Challenger was at Juan Fernandez from the evening of the 13th to the evening of the 15th of November 1875, and reached the cost of Patagonia on the 31st December at Port Otway, east of Cape Tres Montes. On the 1st of January 1876 a party landed on Penguin Island in Messier's Channel, and the same evening the ship arrived in Cove Bay. On the 2d January parties were landed on Middle Island, on the 3d at Gray Harbour, on the 4th at Grappler Harbour, on the 5th and 6th at Tom Bay, near the Trinidad Passage, and small collections were made at each place. On the 8th of January the ship arrived at Porto Bueno, and remained there till the 10th. The same evening a party was landed at Isthmus Bay, and a few birds were obtained. From the 11th to the 13th the Challenger remained at Port Churrucha, and proceeded thence to Port Famine. From the 14th to the 17th she was at anchor off Sandy Point, whence she proceeded through the straits, and anchored about 10 A.M. on the 18th off Elizabeth Island. Leaving the Magellan Straits the Challenger arrived at Port Stanley, Falkland Islands, on the 23d of January 1876, and remained altogether about two weeks at the Falklands.

During this entire period 169 specimens of birds were collected, which are referable to 41 species.

The ornithology of this part of the world is well known to us[1] from the researches of

[1] See Address on Geographical Zoology in Rep. Brit. Assoc., 1875, p. 105, and List of Papers on the Birds of Chili, Proc. Zool. Soc., 1867, p. 108.

Darwin, Cunningham, Philippi, and Landbeck, and other naturalists. It was not to be expected, therefore, that any novelties would be found during such a cursory passage along the coast.

1. *Turdus falklandicus*, Quoy et Gaim.

*Turdus falklandicus*, Quoy et Gaim.: Scl. et Salv., Nomencl., p. 2; Scl., Proc. Zool. Soc., 1878, p. 431.

[Nos. 619–621. Males.
Nos. 622–625. Females. } Juan Fernandez.
Eyes brown; bill and legs yellow; feet a little darker yellow.
No. 647. Male.
No. 648. Female. } Gray Harbour, Messier's Channel.
Eyes brown. Stomachs had berries.
No. 685. Male.
No. 686. Female. } Port Churrucha.
Eyes brown. Stomachs had berries.]

The occurrence of this Thrush in Juan Fernandez is new to us. The skins from that island do not differ from continental specimens. Specimens Nos. 647, 648, from Gray Harbour, Messier's Channel, and No. 685 from Port Churrucha (obtained in the month of January), are in nestling-plumage. The lower surface is thickly spotted with black; and the back-feathers carry light fulvous shaft-stripes, and are tipped with black.

Eggs of this Thrush were obtained in the Falklands. They have already been described by Mr Gould (Proc. Zool. Soc., 1859, p. 94).

2. *Hirundo meyeni*, Cab.

*Hirundo meyeni*, Cab.: Scl. et Salv., Nomencl., p. 14; Scl., Proc. Zool. Soc., 1878, p. 432.

[No. 709. Male.
Nos. 710, 711. Females. } Sandy Point.
Eyes black. Stomachs had insects.]

3. *Phrygilus gayi*, Eyd. et Gerv.

*Phrygilus gayi*, Scl. et Salv., Nomencl., p. 31; Scl., Proc. Zool. Soc., 1878, p. 432.

[Nos. 662, 663. Females. Porto Bueno.
Eyes red. Stomachs had sand and grubs.]

4. *Phrygilus melanoderus*, Quoy et Gaim.

*Phrygilus melanoderus*, Scl. et Salv., Nomencl., p. 31; Proc. Zool. Soc., 1878, p. 432.

[No. 727. Male. Falkland Islands.

Eyes black. Stomach had seeds.]

Two eggs obtained at the Falklands are, no doubt, referable to this little Finch. They have been already described by Mr Gould (Proc. Zool. Soc., 1859, p. 95).

5. *Zonotrichia canicapilla*, Gould.

*Zonotrichia canicapilla*, Sclater, Ibis, 1877, p. 47, pl. i. fig. 1; Scl. et Salv., Proc. Zool. Soc., 1878, p. 432.

[Nos. 702, 703. Females. Sandy Point.
Eyes brown. Stomachs had insects.]

These skins are of young birds, and in a stage in which they cannot be distinguished from *Zonotrichia pileata;* but from their locality they should belong to *Zonotrichia canicapilla*.

6. *Curæus aterrimus*, Kittl.

*Curæus aterrimus*, Scl. et Salv., Nomencl., p. 38; Proc. Zool. Soc., 1878, p. 432.

[No. 645. Male. Gray Harbour.
Eyes black. Stomach had insects.]

7. *Centrites niger*, Bodd.

*Centrites niger*, Scl. et Salv., Nomencl., p. 44; Proc. Zool. Soc., 1878, p. 432.

[Nos. 705–707. Males.
Nos. 708, 708*a*. Females. } Sandy Point.
Eyes black. Stomachs had insects.]

8. *Anæretes parulus*, Kittl.

*Anæretes parulus*, Scl. et Salv., Nomencl., p. 47; Proc. Zool. Soc., 1878, p. 432.

[No. 665. Female. Porto Bueno.
Eyes grey.]

9. *Anæretes fernandezianus*, Philippi.

*Anæretes fernandezianus*, Scl., Ibis, 1871, p. 179, pl. vii. fig. 1; Scl. et Salv., Nomencl., p. 47; Proc. Zool. Soc., 1878, p. 432.

[Nos. 606–613. Males. Juan Fernandez.
Eyes white. Insects in stomachs.]

10. *Elainea albiceps*, D'Orb. et Lafr.

*Elainea albiceps*, Scl. et Salv., Nomencl., p. 48; Proc. Zool. Soc., 1878, p 433.

[No. 688. Male. Port Churrucha.
Eyes black.]

11. *Tænioptera pyrope*, Kittl.

*Tænioptera pyrope*, Scl. et Salv., Nomencl., p. 42; Proc. Zool. Soc., 1878, p. 433.

[No. 704. Male. Sandy Point.
Eyes black. Stomach had insects.]

12. *Cinclodes patachonicus*, Gm.

*Cinclodes patachonicus*, Scl. et Salv., Nomencl., p. 62; Proc. Zool. Soc., 1878, p. 433.

[No. 629. Male.
No. 630. Female. } Port Otway.
Eyes hazel, feet horn-colour.
No. 641. Male.
No. 642. Young male. } Messier's Channel, Cold Harbour.
Eyes brown.
No. 642. Obtained January 2: a nestling lately flown.

13. *Scytalopus magellanicus*, Lath.

*Scytalopus magellanicus*, Scl. et Salv., Nomencl., p. 76; Proc. Zool. Soc., 1878, p. 433.

[No. 675. Male.
No. 676. Female. } Porto Bueno.
Eyes black. Stomachs had insects.
No. 680. Male. Isthmus Bay.
Eyes brown.]

14. *Pygarrhicus albigularis*, King.

*Pygarrhicus albigularis*, King: Scl. et Salv., Nomencl., p. 67; Proc. Zool. Soc., 1878, p. 433.

[No. 674. Male. Porto Bueno.
Eyes grey. Stomach had insects.]

15. *Oxyurus spinicauda*, Gm.

*Oxyurus spinicauda*, Gm.: Scl. et Salv., Nomencl., p. 62; Proc. Zool. Soc., 1878, p. 433.

[No. 631. Female. Port Otway.

Eyes black. Stomach had insects.
No. 664. Female. Porto Bueno.
Eyes brown.
No. 687. Male. Port Churrucha.
Eyes brown.]

16. *Eustephanus galeritus*, Mol.

*Eustephanus galeritus*, Scl. et Salv., Nomencl., p. 90; Scl., Ibis, 1871, p. 181; Proc. Zool. Soc., 1878, p. 433.

[Nos. 614–616. Males. } Juan Fernandez.
No. 617. Female. }
Eyes black; legs black.
No. 677. Male. Porto Bueno.
Eyes black.]
The occurrence of this Humming-bird on Juan Fernandez is now confirmed.

17. *Eustephanus fernandensis*, King.

*Eustephanus fernandensis*, King: Scl. et Salv., Nomencl., p. 90; Scl., Ibis, 1871, p. 180; Proc. Zool. Soc., 1878, p. 434.

[Nos. 575–580, 582, 583, 585, 588–592. Males. }
Nos. 593, 594. Males (young). } Juan Fernandez.]
Nos. 595–600, 603, 605. Females. }

Of Nos. 575 to 592 it is noted by Mr Murray—"All males; eyes black; feet and bill black. Insects in stomachs. This was the most abundant bird on the island apparently. It would seem to be the male of the next lot (595–605)."

Of the last-mentioned lot Mr Murray noted—"I think there are strong reasons for believing that these are the females of the preceding. They were several times shot together on the same tree."

There can be no question of Mr Murray's view being correct. See my notes on this subject in Ibis, 1871, p. 181.

18. *Campephilus magellanicus*, Gm.

*Campephilus magellanicus*, Gm.: Scl. et Salv., Nomencl., p. 98; Proc. Zool. Soc., 1878, p. 434.

[No. 667. Male. } Porto Bueno.
No. 668. Female. }
Eyes yellow; feet and bill black. Stomachs had insects.]

19. *Ceryle stellata*, Meyen.

*Ceryle stellata*, Meyen: Scl. et Salv., Nomencl., p. 103; Proc. Zool. Soc., 1878, p. 434.

[No. 628. Male. Port Otway.
Eyes black; feet yellowish-green. Stomach was empty.
No. 638. Male. Corr Harbour.
Eyes brown. Stomach had fish-bones.
No. 649. Male. Gray Harbour.
Eyes black. Stomach was empty.]

20. *Conurus smaragdinus*, Gm.

*Conurus smaragdinus*, Gm.: Scl. et Salv., Nomencl., p. 112; Proc. Zool. Soc., 1878, p. 434.

[No. 696. Male.
Nos. 697–699. Females. } Sandy Point.
Eyes red; bill and legs horn colour. Stomachs had seeds.]

21. *Asio brachyotus*, Forst.

*Otus brachyotus*, Scl. et Salv., Nomencl., p. 116; Proc. Zool. Soc., 1878, p. 434.

[No. 712. Male. Sandy Point.
Eyes yellow; bill black. Stomach had a mouse in it.
No. 717. Male. Elizabeth Island.
Eyes yellow; cere yellow; bill black. Stomach had remains of mouse.]

22. *Geranoaëtus melanoleucus*, Vieill.

*Geranoaëtus melanoleucus*, Vieill.: Scl. et Salv., Nomencl., p. 119; Proc. Zool. Soc., 1878, p. 434.

[No. 713. Female. Elizabeth Island.
Eyes brown; cere yellow; tip of bill black; legs yellow. Stomach had goslings.]

23. *Tinnunculus sparverius*, Linn.

*Tinnunculus sparverius*, Scl. et Salv., Nomencl., p. 121; Proc. Zool. Soc., 1878, p. 434.

[No. 700. Male. Sandy Point.
Eyes brown; feet yellow; bill bluish. Stomach had remains of mouse.
No. 701. Female. Sandy Point.
Eyes brown; legs yellow; cere yellow; bill blue. Stomach had remains of small bird.
Nos. 715, 716. Females. Elizabeth Island.

Eyes brown; legs yellow; cere yellow.]

These specimens all belong to the form kept distinct by Mr Sharpe (Cat. Birds, vol. i. p. 439) under Swainson's title *cinnamominus*. But when a large series is examined, we find so many intermediate forms between the typical *Tinnunculus sparverius* and *Tinnunculus cinnamominus* on the one hand and *Tinnunculus isabellinus* on the other, that it seems better to keep these three continental forms all under one specific designation. On the one hand, the insular forms *Tinnunculus leucophrys* and *Tinnunculus sparverioides* of Cuba, and *Tinnunculus dominicensis* of the other Antilles, seem to be fairly distinct.

24. *Milvago chimango*, Vieill.

*Milvago chimango*, Scl. et Salv., Nomencl., p. 122; Proc. Zool. Soc., 1878, p. 435.

[Nos. 669, 670. Females. Porto Bueno.
Eyes brown; feet bluish grey.
No. 695. Male. Sandy Point.
Eyes brown; bill yellowish tinge; legs blue.]

25. *Polyborus tharus*, Mol.

*Polyborus tharus*, Scl. et Salv., Nomencl., p. 123; Proc. Zool. Soc., 1878, p. 435.

[No. 679. Male. Isthmus Harbour.
Eyes brown; bill blue; cere flesh coloured; and legs flesh coloured.
No. 684. Male. Port Churrucha.
Eyes brown; cere orange; legs yellow; bill bluish tinge.]

26. *Cathartes aura*, Linn.

*Cathartes aura*, Linn.: Scl. et Salv., Nomencl., p. 123; Proc. Zool. Soc., 1878, p. 435.
*Œnops falklandica*, Sharpe, Cat. Birds, vol. i. p. 27, pl. ii.

[No. 731. Female. Falkland Islands.
Eyes brown; had remains of birds in the stomach.]

We consider Mr Sharpe's generic and specific names for this Vulture alike unnecessary. Illiger in his Prodromus (1811), gave two types for his genus "*Cathartes*," *Vultur papa* and *Vultur aura*. In 1816 Vieillot made two genera, *Gypagus* for *Vultur papa* and *Catharista* for *Vultur aura* and *Vultur atratus*. *Cathartes*, however, has been generally used for the latter group; and there is, in our opinion, no reason whatever for transferring it back to the former, which has an excellent and appropriate name in *Gypagus*. There seem to us to be no sufficient characters to separate the red-headed and black-headed species of *Cathartes* into two genera.

As regards the Falkland Island form of *Cathartes aura*, which Mr Sharpe designates

*Œnops falklandica*, the differential character relied upon, which is, apparently, merely the slight greyish-brown margination of the secondaries, appears to us to be insufficient.

Eggs of this bird were obtained by the Challenger naturalists. They have already been described by Mr Gould (Proc. Zool. Soc., 1859, p. 93).

27. *Nycticorax obscurus*, Bp.

*Nycticorax obscurus*, Scl. et Salv., Nomencl., p. 126; Proc. Zool. Soc., 1878, p. 436.
*Nycticorax americana*, Gould, Proc. Zool. Soc., 1859, p. 96.

[No. 655. Female. Tom Harbour.
Eyes orange; feet greenish-yellow. Stomach had fish.
No. 666. Female. Porto Bueno.
Eyes orange.
No. 737. Female. Falkland Islands.
Eyes yellow. Stomach had crustacea.]

Eggs of this species were obtained. They have been already described by Mr Gould (*l.c.*)

28. *Theristicus melanopis*, Gm.

*Theristicus melanopis*, Scl. et Salv., Nomencl., p. 127; Proc. Zool. Soc., 1878, p. 436.

[No. 691. Male.
No. 692. Female. } Sandy Point.
Female, eyes red; feet pink; bill black.
Male, eyes yellow; bill green; legs pinkish with black scales.]

29. *Bernicla antarctica*, Gm.

*Bernicla antarctica*, Gm.: Scl. et Salv., Nomencl., p. 128; Proc. Zool. Soc., 1878, p. 436

[No. 632. Male.
No. 633. Female.
No. 634. Young.
No. 635. Young. } Penguin Islands. Messier Channel.

Eyes brown; feet yellow; bill of male black, of female flesh colour; bill of young dark; feet grey-brown. Stomachs had pieces of small stones, shells, and sea-weed."

No. 736. Female. Falkland Islands.]

The two goslings (634, 635, obtained January 1) are just changing their down, and present the black back, brown head, and barred wings and under surface of the adult female partially developed. The sex is not noted in either of them.

30. *Bernicla poliocephala*, Scl.

*Chloëphaga poliocephala*, Scl. et Salv. Nomencl., p. 128; Proc. Zool. Soc., 1878, p. 436.

[No. 643. Male.
No. 644. Female. } Gray Harbour.
Eyes brown; feet and legs yellow and black. Stomachs had grass and berries.
No. 658. Female.
No. 659. Female.
No. 658*a*. Young. } Tom Harbour.
No. 658*b*. Young.
Eyes brown; bill black; feet yellow and black.]

31. *Mareca sibilatrix*, Poepp.

*Mareca sibilatrix*, Scl. et Salv., Proc. Zool. Soc., 1876, p. 395, et 1878, p. 436.

[No. 719. Male. Elizabeth Island.
Eyes grey; bill black; feet black. Stomach had sand, &c.]

32. *Spatula platalea*, Vieill.

*Spatula platalea*, Scl. et Salv., Nomencl., p. 130; Proc. Zool. Soc., 1878, p. 436.

[No. 694. Male. Sandy Point.
Eyes white; bill black; feet yellow. Stomach had pebbles, &c.]

33. *Tachyeres cinereus*, Gm.

*Tachyeres cinereus*, Scl. et Salv., Proc. Zool. Soc., 1876, p. 402, et 1878, p. 437.
*Micropterus cinereus*, Cunningham, Trans. Zool. Soc., vol. vii. p. 493.

[No. 651. Female (young). Messier's Channel.
Eyes brown. Stomach had crabs.
No. 656. Young. Messier's Channel.
Eyes brown; feet and bill black.
No. 657. Female. Tom Harbour.
Eyes brown; bill yellow tipped with black; feet yellow. Stomach had small pieces of sand.
No. 678. Male. Straits of Magellan.
Nos. 681, 682. Females. Port Churrucha.
Weighed 8 lbs. and 8½ lbs.
Nos. 725, 726. Males (young). Falkland Islands.
Stomach had shells from the kelp chiefly. Bill black; feet yellow-brown.]
There is nothing in the present series which would induce us to question Dr Cunning-

ham's view, that the "Flying Loggerhead" is the young of the ordinary species before it gets too heavy for flight. Such a specimen a "No. 681, young female," could evidently accomplish flight, which in large fully adult birds would be probably impossible.

In all the immature birds the bill is uniform black.

34. *Columba œnas*, Linn.

*Columba œnas*, Scl. et Salv., Proc. Zool Soc., 1878, p. 437.

[No. 626. Male.
No. 627. Female. } Juan Fernandez.
Eyes orange; feet red; bill black.]

No doubt an introduced bird. The two specimens vary in plumage.

35. *Rallus antarcticus*, King.

*Rallus antarcticus*, Scl. et Salv., Nomencl., p. 139; Proc. Zool. Soc., 1878, p. 437.

[No. 693. Female. Sandy Point.
Eyes red; bill black; feet yellow. Stomach had pebbles.]

36. *Vanellus occidentalis*, Harting.

*Vanellus occidentalis*, Harting, Proc. Zool. Soc., 1874, p. 451; Scl. et Salv., *Ibid.*, 1878, p. 437.
*Vanellus cayennensis*, Sclater, Proc. Zool. Soc., 1867, p. 331; Scl. et Salv., Nomencl., p. 142 (*partim*).

[No. 722. Male. Elizabeth Island.
Eyes pink; legs pink; bill black at tip, pink at base.]

The characters given by Mr Harting to separate this western form from *Vanellus cayennensis* are slight, but, we think, on the whole, sufficient to justify the employment of his name.

37. *Hæmatopus leucopus*, Garnot.

*Hœmatopus leucopus*, Scl. et Salv., Nomencl., p 143; Proc. Zool. Soc., 1878, p. 437.

[No. 636. Male. Penguin Islands.
Bill red; legs flesh coloured; eyes orange.
No. 653. Female. }
No. 654. Young. } Tom Harbour.
Eyes orange. Stomach had mussels.

Eyes of young were brown; bill of adult red; feet flesh coloured; bill of young brown.

No. 661. Female. Tom Harbour.
No. 720. Male. Elizabeth Island.
Eyes yellow; feet flesh coloured; bill red; eyelids red. Stomachs had mussels.]

38. *Hæmatopus ater*, Vieill.

*Hæmatopus ater*, Scl. et Salv., Nomencl., p. 143; Proc. Zool. Soc., 1878, p. 438.

[No. 721. Female. Elizabeth Island.
Eyes yellow; feet flesh coloured; bill red; eyelids red. Stomach had mussels.]

39. *Eudromias modesta*, Licht.

*Eudromias modesta*, Scl. et Salv., Nomencl., p. 143; Proc. Zool. Soc., 1878, p. 438.

[No. 646. Female. Gray Harbour.
Eyes brown. Stomach had insects.
No. 660. Female. Tom Harbour.
Eyes black. Stomach had insects.
No. 673. Male. Porto Bueno.
Eyes brown. Stomach had seeds and sand.
No. 698. Male. Port Fanurie.
Eyes brown. Stomach had sand.
No. 728. Male. Falkland Islands.
Eyes brown. Stomach had sandy particles, &c.]

40. *Gallinago paraguaiæ*, Vieill.

*Gallinago paraguaiæ*, Scl. et Salv., Nomencl., p. 144; Proc. Zool. Soc., 1878, p. 438.

[Nos. 671, 672. Females. Porto Bueno.
Eyes brown; feet bluish. In No. 672 the feet are yellowish.
No. 729. Male.
No. 730. Female. } Falkland Islands.
Eyes brown. Stomach had worms, &c.]

41. *Tringa fuscicollis*, Vieill.

*Tringa fuscicollis*, Vieill.: Scl. et Salv., Nomencl., p. 145; Proc. Zool. Soc., 1878, p. 438.

[No. 733. Male. Falkland Islands.
Eyes brown. Stomach had sand, &c.]

## VIII.—*On the Birds collected on the Atlantic Islands and Kerguelen Island, and on the Miscellaneous Collections.* By P. L. Sclater, M.A., F.R.S.

(Plates XXIII., XXIV.)

(Reprinted from Proc. Zool. Soc., 1878. With additions by P. L. Sclater, F.R.S.)

In this chapter I propose to complete the land-birds by giving some account of the specimens obtained on the Tristan da Cunha group and Kerguelen Island, and of a few small collections made at various other localities which were touched at during the course of the Expedition. I have arranged all these, according to the dates at which the places were visited, as follows :—

| | Date. | No. of Specimens. |
|---|---|---|
| *A.* St Iago, Cape Verd, | July 1873 | 4 |
| *B.* Tristan da Cunha, | October 1873 | 12 |
| *C.* Kerguelen Island, | January 1874 | 16 |
| *D.* New Zealand, | June 1874 | 4 |
| *E.* Hong Kong, | December 1874 | 7 |
| *F.* Meangis Islands, | February 1875 | 3 |
| *G.* At sea, | February 22, 1875 | 2 |
| *H.* Humboldt Bay, New Guinea, | February 24, 1875 | 2 |
| *I.* At sea, | April 7, 1875 | 5 |
| *J.* Japan, | May 1875 | 4 |
| | | 59 |

### *A.* ST IAGO, CAPE VERD (July 1873).

Four examples of the peculiar King-hunter of this island, *Halcyon erythrogastra*, Temm. (Sharpe's Kingf., p. 171, pl. lxiii.), were obtained here. In one specimen the eyes are marked "black," and the contents of the stomach "insects."

### *B.* TRISTAN DA CUNHA GROUP.

This remote group consists of three islands—Tristan da Cunha, Nightingale and Inaccessible Islands, and a fourth smaller island, Gough Island, which lies 200 miles off to the south, but which, according to Mr Moseley, should be included. Many

most interesting details concerning the physical character, animals, and vegetation of these islands have been given by Sir Wyville Thomson (The Atlantic, vol. ii. p. 151) and Mr Moseley (Naturalist on the Challenger, p. 108).

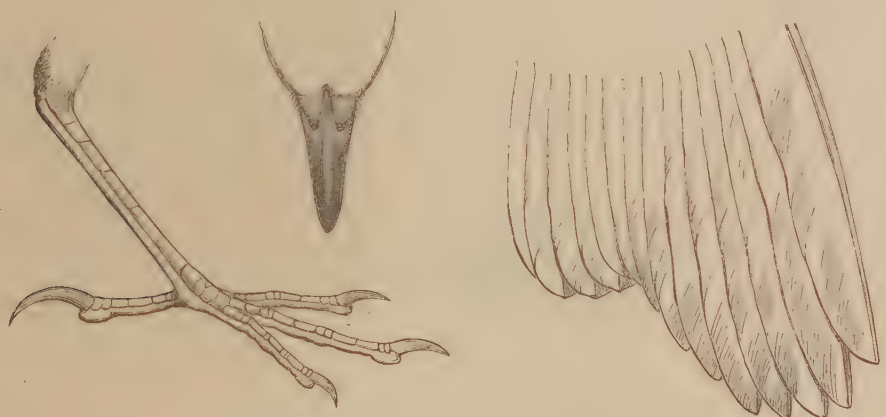
The only previously published notes on the birds of the Tristan da Cunha group are, I believe, those of Captain Carmichael[1] in the Linnean Transactions.

The land-birds collected by the Challenger consist of twelve skins referable to two species, namely—

1. *Nesocichla eremita* (Pl. XXIII.).

*Turdus guianensis* (?), Carm., Trans. Linn. Soc., vol. xii. p. 496.
*Nesocichla eremita*, Gould, Proc. Zool. Soc., 1855, p. 165; Scl., *Ibid.*, 1878, p. 577.

Of this curious Thrush, of which a figure (taken from specimen *f*) is now given for the first time, seven examples were obtained in Tristan da Cunha on the 15th



Head, foot and wing of *Nesocichla eremita*.

of October 1873. These specimens are not determined as to sex, but as they are all alike we may conclude that the female does not differ in plumage from the male. The eye is marked as "black" upon all the specimens.

This Thrush is found also on Inaccessible Island, as we learn from Mr Moseley's notes. Having landed on this island on the 17th of October, and passed through a large Penguin-rookery situated in the tussock-grass (*Spartina arundinacea*), Mr Moseley entered a small copse of *Phylica arborea* (*op. cit.*, p. 121). Here he found this Thrush hopping and fluttering about in abundance. It feeds especially on the bright red berries of *Nertera depressa*, but is also to be seen picking the bones of other birds that have fallen victims to the Skuas (*Stercorarius antarcticus*). The Thrush breeds in the

[1] Some Account of the Island of Tristan da Cunha and of its Natural Productions. By Captain Dugald Carmichael, F.L.S., Trans. Linn. Soc., vol. xii. p. 483.

tussock-grass a few feet from the ground in the beginning of October, and lays usually two eggs, which resemble those of the Black-bird (*Turdus merula*).

"It was here," Mr Moseley continues, "that we first encountered that remarkable tameness and ignorance of danger in birds which has been so constantly noticed by voyagers landing on little frequented islands, and notably by Darwin, who dilates on the fact in his account of the Galapagos Archipelago.

"The Thrushes hopped unconcernedly within a yard or two of us, whilst stone after stone was hurled at them, and till they were knocked over, and often sat still on a bough to be felled with a walking-stick. By whistling a little as one approached them, numbers could be thus killed, and yet the Germans with their house close by had been constantly thus killing the thrushes for eating for two years. The birds are, however, not quite so tame in Tristan Island."

2. *Nesospiza acunhæ* (Pl. XXIV.).

*Emberiza brasiliensis*, Carm., Trans. Linn. Soc., vol. xii. p. 496.
*Nesospiza acunhæ*, Cab., Journ. für Orn., 1873, p. 154.

Five examples of this peculiar Finch were obtained in Inaccessible Island on October 16, 1873. The eyes are marked "hazel." There is little difference in the plumage of these specimens, of which the sex is not noted. The figures are taken from specimen *d*.

Head, foot, and wing of *Nesospiza acunhæ*.

Dr Cabanis described this species from a specimen in the Berlin Museum, which was bought at the dispersal by auction of the Bullock Collection. He described at the same time another Finch (*Crithagra insularis*), also stated to be from Tristan da Cunha, but which the Challenger naturalists do not appear to have heard anything of. It is very likely that there may have been some error in the locality of the last-named species.

Mr Moseley met with this Finch on Inaccessible Island in the same spot as the *Nesocichla*. It eats the fruit of the *Phylica arborea*, of which the copses that it inhabits are composed. This Finch is stated to be now extinct in Tristan da Cunha

itself.[1] Sir C. Wyville Thomson tells us (Atlantic, vol. ii. p. 178) that this Finch "builds in the bushes, and lays four or five eggs very like those of the common Canary."

A third land bird, which still exists on Tristan da Cunha, though no specimens were obtained by the Challenger Expedition, is *Gallinula nesiotis*, mihi (Proc. Zool. Soc., 1861, p. 261, pl. xxx.). The "Island-hen," as the inhabitants call it, lives on the higher plateau of the island, and is "scarcely able to fly."

From Sir Wyville Thomson's Atlantic (vol. ii. p. 185) we learn that there is also an "Island-hen" on Inaccessible Island of a different species, and one on Gough Island, which however may be *Gallinula nesiotis*.[2] Sir Wyville says :—

"Inaccessible, like Tristan, has its 'Island-hen,' and it is one of my few regrets that we found it impossible to get a specimen of it. It is probably a *Gallinula*, but it is certainly a different species from the Tristan bird. It is only about a fourth the size, and it seems to be markedly different in appearance. The Stoltenhoffs were very familiar with it, and described it as being exactly like a black chicken two days old, the legs and beak black, the beak long and slender, the head small, the wings short and soft and useless for flight. It is common on the plateau, and runs like a partridge among the long grass and ferns, feeding upon insects and seeds."

The oceanic birds of the Cunha group, of which specimens were obtained by the naturalists of the Challenger, consist (as will be seen in the subsequent chapters) of three Terns (*Sterna vittata*, *Anous stolidus*, and *Anous melanogenys*), a Skua (*Stercorarius antarcticus*), one Penguin (*Eudyptes chrysocome*), and two Petrels (*Pelagodroma marina*, and *Œstrelata mollis*). Besides these the Giant Petrel (*Ossifraga gigantea*) and three species of Albatross (*Diomedea*) are spoken of by Sir C. Wyville Thomson.[3]

## *C.* KERGUELEN ISLAND (January 1874).

The only land-birds from Kerguelen Island in the collection are nine specimens of *Chionis minor* and seven of *Querquedula eatoni;* and these are the only land-birds included by Mr Sharpe in his memoir published in the Royal Society's volume on the Transit Expedition of 1875.

The female of the *Querquedula* (of which there is one example determined as such, and two others, evidently of the same sex) differs from the male not only in the absence of the green alar speculum, but also in its smaller size, in the fuscous edgings to the feathers generally, and in the much shorter tail. There is also one chick of this species in the collection.

From Mr Moseley's Notes I extract the subjoined interesting account of this bird :—

"Teal were shot in great numbers by our party. The Teal of Kerguelen Island (*Querquedula eatoni*) is peculiar to the island and the Crozets.

[1] Moseley, *op. cit.*, p. 122. [2] Wyville Thomson, Atlantic, vol. ii. p. 184. [3] *Ibid.*, vol. ii. pp. 183, 184.

"It is somewhat larger than our common Teal, and of a brown colour, with a metallic blue streak, and some little white on the wing. It is enormously abundant all about Kerguelen Island, near the coast. I killed in one day twenty-seven Teal, and similar bags were frequent.

"Four or five guns used to bring back usually over 100 birds.

"The Teal feed mainly on the fruit of the Kerguelen cabbage, and are extremely good eating. They were the greatest treat possible to us, living, as we necessarily were, almost entirely on preserved meat.

"The Teal are to be found mostly in flocks, or when breeding in pairs. They are, where they have not been shot at by sealers, remarkably tame, and require to be kicked up almost to afford a shot.

"At one valley near Three Island Harbour in Royal Sound, which had probably not been visited by man for thirty or forty years, perhaps hardly ever, after tramping some distance after Teal without success, I saw a flock get up from the bed of a river which ran down the valley, about 150 yards off. I thought the birds must be wild and had been recently shot at; but no, they got up merely to come and look at me. They pitched about 40 yards off, and then set off running towards me in line, like farm-yard ducks, seven of them in a row, headed by a Drake.

"As a sportsman I hesitate to describe the termination of the scene. Only those who have been long at sea know what an intense craving for fresh meat is developed by a constant diet of preserved and salt food. The Teal were most excellent eating, and there were many mouths to feed. My rule was always to shoot them on the ground if I could, and as many at a shot as possible. When I could not do this I took them flying, and with tolerable success.

"Some of the Teal were breeding at the time of our visit, some with young full-fledged and already away from the nest, others with eggs. The nest is a neat one, placed under a tuft of grass, and lined with down torn from the breast of the parent bird. There were five eggs in one nest that I found.

"The duck, when put up off the nest, to effect which the nest required almost to be trodden upon, or when found with her young away from the nest, flutters a few yards only as if maimed, and pitches again, and cannot be frightened into a long flight. It is curious that the bird should have retained this instinct where there are no four-footed or human enemies; possibly she finds it a successful ruse when the brood is attacked by the Skuas.

"The young must fall constantly a prey to these ever-watchful Skuas, for in most cases I found only a single young one following the mother. There were no young met with in the condition of flappers; and the general breeding season was probably only about to begin, as it was with many birds of the island. The greater part of the birds were yet in flocks."—(Moseley, Notes, pp. 190, 191.)

There are seven eggs of this duck in the collection. They are of the usual size and appearance of the eggs of this genus, being of a uniform pale stone colour, and measuring about 2·1 by 1·4 inches.

### *D.* NEW ZEALAND (June 1874).

In New Zealand only four skins, belonging to three species, were obtained, namely :—

1 *Miro albifrons*, jr., Hardy Bay.
2 *Hæmatopus unicolor*, jr., Hardy Bay.
1 *Botaurus pœciloptilus*, jr., Wellington.

### *E.* HONG KONG, CHINA (January 1875).

From Hong Kong seven skins, belonging to four species, all known Chinese birds, were procured, viz. :—

1 *Turdus mandarinus*, Bp.
1 *Halcyon pileata*, Bodd.
2 *Alcedo bengalensis*, Gm.
2 *Coturnix communis*, Bonn.
1 *Turnix maculosus*, Temm.

### *F.* MEANGIS ISLANDS (February 1875).

Four examples of *Eos indica* were obtained here (of which three have arrived home), under the circumstances mentioned in Mr Murray's MS., as follows :[1]—

"On the 10th February 1875, while the ship was dredging, some natives came off in a boat. They had with them mats and cocoa-nuts, and some Perroquets. The following are those which were purchased for tobacco :—

"No. 440. ♀.
No. 441. ♀.
No. 442. ♀.
No. 443. ♂.
} Feet black; bill orange; eyes red, or light brown in the male.

"We kept the male for several days alive; he used to fly about the ship and return to the house on deck when shown his food.

"He died from eating some green stuff, it is supposed, but was perhaps hurt aloft.

"The natives came from the southernmost isle of the Meangis group.

"This is the most northern species of *Eos* known; its only hitherto ascertained locality is the neighbouring Sanghir group of islands."[2]

[1] *Cf.* also Lord G. Campbell's Log-letters, p. 245.
[2] *Cf.* Rowley's Orn. Misc., p. 123, where a beautiful figure of this species is given.

*G.* AT SEA (February 22, 1875).

Two examples of *Phalaropus hyperboreus* in winter plumage (Nos. 445, 446, both "females") were "shot by Mr Moseley on February 22, 1875, among the drift wood." Mr Murray "saw many the previous day."

This Phalarope is said to wander occasionally even as far south as the Arrou Islands.[1] The present examples were obtained the day before the ship arrived at Humboldt Bay, New Guinea.

*H.* HUMBOLDT BAY, NEW GUINEA (February 23, 1875).

At this most interesting locality only two birds, unfortunately, were obtained, namely :—

No. 447. *Trichoglossus cyanogrammus*, Wagl.

No. 448. *Arses insularis*, Meyer.

The first of these is a well-known Papuan species. Of the second (shot by Mr Murray under the circumstances mentioned in Lord George Campbell's Log-letters, p. 253) the only specimens yet known were obtained by Dr A. B. Meyer on the island of Jobi.[2] Its occurrence on the mainland is, therefore, of much interest.

Mr Murray notes of this specimen :—"Male. Eyes brown; ring round the eye large and of a delicate sky-blue; bill and legs of a darker blue or violet.

"I landed in Humboldt Bay from the pinnace in a native canoe; and with some of the natives went a short way into the woods. Was not much over half an hour on shore. It was then that I shot the above two birds. I saw a Tern and a small Swift, also some Cockatoos, but all out of shot. I fired at another small bird, but did not get it. I also saw three Goura Pigeons, very fine large ones, and after a time got a shot at one, but did not bring it down. I should have had several more birds, but had to return to the boat on the signal."

*I.* AT SEA (April 7, 1875).

Four days before arriving at Yokohama, and nearly due south of that port, five specimens of *Hirundo gutturalis*, the eastern form of our familiar *Hirundo rustica*, were "caught round the ship. They were apparently in an exhausted state."

*J.* JAPAN (May 1875).

In Japan four specimens of birds were obtained—an example of *Buteo japonicus*, Bp.,

[1] *Cf.* Dresser, B. Europe.

[2] *Monarcha insularis*, Meyer, Sitz. Ak. Wien, vol. lxix. p. 395.

in Jedo Bay, and a hen *Phasianus versicolor* and two specimens of *Terekia cinerea* from the Inland Sea.

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## IX.—*On the Steganopodes and Impennes, collected during the Expedition.* By P. L. Sclater, M.A., Ph.D., F.R.S., and Osbert Salvin, M.A., F.R.S.

(Plates XXV.–XXX.)

(Reprinted from the Proceedings of the Zoological Society, 1878. With Additions and Corrections by P. L. Sclater, F.R.S.)

### *A.* STEGANOPODES.

Of this order the collection contains 33 specimens belonging to 9 species, as follows :—

#### 1. Fregatidæ.

1. *Fregata aquila*, Linn.

*Fregata aquila*, Scl. et Salv., Proc. Zool. Soc., 1878, p. 650.

[*a*. Adult.
*b*. Young.
*c*. Young. } Ascension Island, March 1876.]

2. *Fregata minor*, Gm.

*Attagen ariel*, Gould, B. Austr., vol. vii. pl. lxxii.
*Fregata minor*, Scl. et Salv., Proc. Zool. Soc., 1878, p. 650.

[No. 133. Male. Raine Island.

Legs and feet black; bill grey; skin of throat red; eyes red. The skin of the throat is of a lighter red in the male than in the female. The stomach contained remains of cuttlefish, *Spirula*, and a fish.

No. 134. Female.
No. 135. Young, female.
No. 136. Nestling, female. } Raine Island.

Feet red; eyes red. The bill and feet of the young birds are of a white colour with a shade of blue; eyes black.

In the adult birds the male has the eyelids, feet, and eyes black. The female has these parts red. This holds good in all our specimens.

No. 144. Female. Raine Island.

No. 482. Male. Admiralty Island.

Eyes black; flesh of throat red. Stomach contained fish. I shot this bird from the pinnace while with several others. It was hovering over a shoal of fish. A Noddy and Black-headed Terns, and a Puffin or Petrel, larger than a Cape-Pigeon, were also fishing.]

The series before us, so far as it goes, tends to show that this smaller Frigate-bird may remain distinct from its larger brother, although we are not aware of any other obvious points of difference than those of size, and, as has been pointed out to us by Captain Legge, of a white patch on the flanks, which appears only on the smaller species.

The specimens measure as follows :—

| | Wing. | Bill from Gape. |
|---|---|---|
| | Inches. | Inches. |
| *Fregata aquila*, *a*, . . . . . | 23·5 | 5·0 |
| „ „ jr., *b*, . . . . . | 23·0 | 4·5 |
| „ „ jr., *c*, . . . . . | 22·0 | 4·4 |
| „ *minor*, ♂, 133, . . . . . | 20·5 | 3·9 |
| „ „ ♀, 134, . . . . . | 20·5 | 4·0 |
| „ „ ♀, 144, . . . . . | 20·5 | 4·0 |
| „ „ ♂, 482, . . . . . | 20·5 | 4·0 |

The bill of *Fregata minor* is also narrower at the base, and more feeble.

[At Raine Island there was a rookery of this Frigate-bird in the centre, of about thirty or forty nests. There were eggs in the nests; and all the young, but one or two, were perched on the branches of a low shrub; these had red heads, and looked very like vultures at first sight. The nests were formed of sticks laid on the tops of small bushes, about one foot from the ground.]

## 2. Phaëthontidæ.

### 3. *Phaëthon æthereus*, Linn.

*Phaëthon æthereus*, Scl. et Salv., Proc. Zool. Soc., 1878, p. 651.

[*a*. Ascension Island, March 1876.

No. 143. Female (young). Raine Island.

Eyes black; legs white; claws black; bill dark brown colour. The only one seen on the Island.

Phaëtons were noticed in the Atlantic from about 36° N. lat. to 23° S. lat., and in the Pacific from 23° N. lat. to 18° S. lat. Of course, we could not tell the species from the ship.]

4. *Phaëthon flavirostris*, Brandt.

*Phaëthon flavirostris*, Scl. et Salv., Proc. Zool. Soc., 1878, p. 651.

[*a*. *b*. } Fernando Noronha, September 1873.

*c*. Male. *d*. Male. } Ascension, March 1876.

*e*. Female. Tongatabou.

This bird came on board at midnight on July 18, 1874. It flew right at the quarter-master's light near the wheel, and nearly knocked it over.

No. 507. Female. At sea, 19th March 1875.

Eyes black; legs lake-white. The claws and membrane between the toes quite black. Bill pale yellow. Came on board the ship on the morning of the 19th March 1875, before daylight. The bill of a cuttlefish was in the stomach.]

## 3. Pelecanidæ.

5. *Sula leucogastra*, Bodd.

*Le Fou de Cayenne*, Buff. Pl. Enl., 973 (*unde*).
*Pelecanus leucogaster*, Bodd., Tabl. de Pl. Enl., p. 57.
*Sula leucogastra*, Salvin, Trans. Zool. Soc., vol. ix. p. 496; Scl. et Salv., Proc. Zool. Soc., 1878, p. 651.

[No. 141. Male. Raine Island.

Eyes grey; feet light green; bill bluish towards the base, white at the tip.

No. 510. Female. At sea.

Eyes white or light grey. Stomach had cuttlefish. Feet yellow with green tinge; bill flesh colour; cere greenish. Came on board the ship on the evening of the 6th April 1875.

*a*. Female. Ascension, March 1876.

*b*. *c*. } St Paul's Rocks, Atlantic, August 1873.

In Raine Island this bird nested in the centre of the island along with *Sula cyanops*.]

6. *Sula piscator*, Linn.

*Pelecanus piscator*, Linn.: S. N., vol. i. p. 217.
*Dysporus piscator*, Finsch et Hartl., Orn. Centr.-Polyn., p. 252; Scl. et Salv., Proc. Zool. Soc, 1878, p. 651.

[No. 123. Female. Off Cape York, at sea; alighted on one of the boats, and was caught by hand.

Eyes brown; bill and throat light blue-reddish towards the base, and the tips of both mandibles brown; feet coral-red. The stomach contained cuttlefish about $3\frac{1}{2}$ and 4 inches long, allied to *Gonatus amœnus*, and the caudal portion of a fish. There were a great many lice on this bird.

No. 139. Female. Raine Island.

Eyes hazel; feet red; bill light blue, red towards the base. Stomach contained fish and cuttlefish.

At Raine Island this *Sula* had its nests away from those of the other two species and amongst those of the Terns. There were eggs in the nests, which were in some cases on the tops of the low bushes.]

7. *Sula cyanops*, Sund.

*Sula cyanops*, Sund., Phys. Sällsk., Tidsckr., 1837, p. 218; Scl. et Salv., Proc. Zool. Soc., 1878, p. 652.
*Dysporus cyanops*, Finsch et Hartl., Orn. Centr.-Pol., p. 252.

[Nos. 137, 138. Females. Raine Island.

Eyes yellow, skin of the throat black, legs and feet slate colour. Stomach contained fish and cuttlefish.

This species was the most abundant of the *Sulas* at Raine Island. It had its nests in the centre of the island. There were eggs in the nests which were on the ground, and merely a slight hole in the earth. Eggs of all these three species of *Sula* preserved. They are all very much alike. I marked the eggs as they were taken from the nest, and when I saw the birds rise. It was difficult to separate them when a lot of them got together. *Sulas* were noticed at sea in the Pacific, from 18° N. to 17° S., and in the Atlantic, from 20° N. to 12° S.]

8. *Phalacrocorax imperialis*, King (Pl. XXV.).

*Phalacrocorax imperialis*, King, Proc. Zool. Soc., 1831, p. 30; Scl. et Salv., *Ibid.*, 8781, p. 652.

[No. 637. Male. Core Harbour, Messier Channel.

Eyes brown. Stomach had shells.

This Cormorant, which has been usually united to *Phalacrocorax caunculatus* of

New Zealand, appears to be quite distinct. It has a broad white patch on the middle of the back in the adult plumage, no crest, and the white extending over the cheeks up to the naked skin round the eye. It has a broad white bar on the upper wing-coverts.

The species of the Falkland Islands, which has hitherto been called *Phalacrocorax carunculatus* (Scl., Proc. Zool. Soc., 1860, p. 391; Abbott, Ibis, 1861, p. 166) is again different, having a recurved crest and the caruncles on the front largely developed. It should probably stand at *Phalacrocorax albiventris*, Lesson's *Carbo albiventer* (Trait. d'Orn., p. 604) being apparently based upon the young of this species.

The accompanying plate represents specimen No. 637, an adult male of *Phalacrocorax imperialis*, and the head of a specimen of *Phalacrocorax albiventris* (Falklands, *Leconte*, Mus. S.-G.) showing the peculiar recurved crest of the latter.

Professor Hutton (Trans. N. Z. Inst., vol. xi. p. 332) has lately written an article on *Phalacrocorax carunculatus* of New Zealand (commonly so called) in which, after a review of the literature of this subject, he points out the differences between the birds of New Zealand and the Falklands, and proposes to call the former *cirrhatus* (Gm.), and and the latter *carunculatus* (Gm.). To follow this course would, in my opinion, only add further to the confusion, the names *cirrhatus* and *carunculatus* having been long considered synonymous. Professor Hutton is likewise unaware that the next following species, of Kerguelen Island, is distinct, and unites it to his *Phalacrocorax carunculatus*.

All Dr Cunningham's examples (Mus. Cantabr.), which we called *Phalacrocorax carunculatus* in our reports on his collection (Ibis, 1870, p. 500, *et aliter*), appear to be referable to *Phalacrocorax albiventus*, of which the range is thus extended to the Magellan Straits. Of two skins of *Phalacrocorax imperialis* from Chiloe (*Reed*), in the collection of Salvin and Godman, one has the white dorsal patch much broader and more distinct than in the Challenger specimen, in the other it is altogether absent. This particular character, no doubt, only appears in the breading season.

A large series of skins, in various plumage, from different localities is required for comparison, before the species hitherto confounded under the name *carunculatus* can be satisfactorily differentiated. But there appear to be certainly four of them, of which the adults in full plumage may be recognised as follows:—

| | | |
|---|---|---|
| *a*. Dorsi postici fascia alba; crista nulla, . . . . . | | 1. *imperialis*. |
| *b*. Dorsi fascia nulla: | | |
| *a'*. Crista nulla, . . . . . | | 2. *verrucosus*. |
| *b'*. Cristati. | gula tota nuda, . . . . . | 3. *albiventris*. |
| | gulæ linea media plumosa, . . . | 4. *carunculatus*. |

9. *Phalacrocorax verrucosus*, Cab. (Pl. XXVI.).

*Halieus* (*Hypoleucus*) *verrucosus*, Cab., Journ. f. Orn., 1875, p. 450.
*Halieus verrucosus*, Cab. et Reich., Journ. f. Orn., 1876, p. 359, tab. 1.
*Phalacrocorax verrucosus*, Sharpe, Zool. of Kerguelen, p. 49; Scl. et Salv., Proc. Zool. Soc., 1878, p. 652.

[*a*. Male.
*b*. Male.
*c*. Male (young).
*d*. Female.
*e*. Female.
*f*. Sex ind. } Betsy Cove, Kerguelen Island, January 1874.

The series of this Shag is quite sufficient to warrant us in adhering to the species as distinct. The principal characters are clearly pointed out by Dr Cabanis in his original description; and a good figure is given of the adult male under the second reference given above. Not one of the six specimens, of which *a*, *b*, and apparently *f* are adult, shows any traces of the white line along the upper wing-coverts, or of the white spot in the middle of the back which distinguish *Phalacrocorax imperialis*. The female *d*, is in young plumage.

The plate (XXVI.) represents an adult male (*a*) and a female (*d*), in immature plumage.

## *B.* IMPENNES.

Of Penguins the collection contains thirty-seven specimens, belonging to six species as follows :—

1. *Aptenodytes longirostris*, Scop.

*Apterodyta longirostris*, Scop., Del. Faun. et Flor. Ins., vol. ii. p. 91.
*Aptenodytes longirostris*, Coues, Pr. Ac. Phil., 1872, p. 193; Sharpe, Zool. Kerg., p. 52; Scl. et Salv., Proc. Zool. Soc., 1878, p. 653.

[*a*. Kerguelen Island.
*b*. Christmas Harbour, Kerguelen.
*c*. Marion Island.
No. 734. Female. } Falklands.
No. 735. Male. }

Eyes brown. The stomach of the female had the remains of cuttlefish, there being many beaks of these and also a weed-like substance. Female weighed 20 lbs.; skin of male weighed 10 lbs.]

An egg obtained at Marion Island, and attributed to this species, is of a uniform chalky white, pyriform in shape, and measures 4·4 by 3·0 inches.

The following is Mr Moseley's account of the breeding habits of this Penguin at Marion Island in December 1873.

"Most interesting, however, by far, amongst all rookeries of Penguins which I have seen, was one of the King Penguins (*Aptenodytes longirostis*) which I met with a little further along the shore. The rookery was on a space of perfectly flat ground of about an acre in extent. It was divided into two irregular portions, a larger and smaller, by some grassy mounds. The flat space itself had a filthy black slimy surface; but the soil was trodden hard and flat. About two-thirds of the space of one of the portions of the rookery, the larger one, was occupied by King Penguins, standing bolt upright, with their beaks upturned, side by side, as thick as they could pack, and jostling one another as one disturbed them.

In the figure the birds' heads are drawn as if held horizontally. This is unnatural. The head and neck should be stretched out vertically, quite straight, with the tip of the beak pointed directly upwards.

The King Penguins stand as high as a man's middle, they are distinguished at once not only by their size, but by two narrow streaks of bright orange yellow, one on each side of the glistening white throat.

Penguins were to be seen coming from and going to the sea from the rookery, but singly, and not in companies like the crested Penguins. The King Penguins when disturbed, made a loud sound like "*urr-urr-urr.*" They run with their bodies held perfectly upright, getting over the ground pretty fast, and do not stop at all. A good many were in bad plumage, moulting, but there were plenty also in the finest plumage. On the small area of the rookery, which consisted of a flat space sheltered all round by grass slopes, and which formed a sort of bay amongst these, communicating with the larger area, by two comparatively narrow passages was the breeding establishment.

These Penguins are said by some observers to set apart regular separate spaces in their rookeries for moulting, for birds in clean plumage not breeding, and again for breeding birds. Here the breeding ground was quite separate, and the young and breeding pairs were confined to this smaller sheltered area. This was the only King Penguin rookery which I saw in full action."

At Kerguelen and at the Falklands, Mr Murray informs me, this Penguin was met with in parties numbering from three to twenty individuals upon the beaches, also upon the mossy low grounds, often a mile or more from the sea. They were either moulting or had quite recently moulted.

2. *Pygosceles tæniatus*, Peale.

*Aptenodytes papua*, Forst., Nov. Comm. Gott., vol. iii. p. 140, tab. 3.
*Aptenodytes tæniata*, Peale, U. S. Expl. Exp., p. 264, 1848.
*Pygosceles wagleri*, Scl., Proc. Zool. Soc., 1860, p. 390.
*Pygosceles tæniata*, Coues, Proc. Ac. Phil., 1872, p. 195; Sharpe, Zool. Kerg., p. 54.
*Pygosceles tæniatus*, Scl. et Salv., Proc. Zool. Soc, 1878, p. 653.

*a–f.* Kerguelen Island.

This Penguin was also met with at Marion Island and Heard Island.

"They were usually met with at Marion Island and in Kerguelen Island in parties of a dozen, or twenty or thirty on the grass close to the shore, and were apparently moulting at the time of our visit. At Christmas Harbour, Kerguelen Island, some lots of them camped at a height of 100 feet at least up the steep but green hill-side at the end of the harbour."—(Moseley, Notes, p. 175.)

[We never came across a rookery of this Penguin. It was generally noticed on the shore, or in a moulting condition some distance inland, in groups of tens and twenties. We saw them at Marion, Kerguelen, Heard and Falkland Islands. They can run very fast, and when met with on the shore they at once make for the water when disturbed, unless they chance to be in moulting condition.

We found fish-bones, cuttlefish-beaks, and stones in the stomachs.]

3. *Spheniscus demersus*, Linn. (Pl. XXVII.).

*Diomeda demersa*, Linn., S. N., vol. i. p. 214.
*Spheniscus demersus*, Temm., Tabl. Méth., p. 107, 1836; Coues, Proc. Ac. Phil., 1872, p. 208; Scl. et Salv., Proc. Zool. Soc., 1878, p. 653.

[*a–d.* Cape of Good Hope.]

Four skins of this species in the collection are very nearly alike. A figure is given (Pl. XXVII.) taken from specimen *a*, in order to show the well-marked points of difference which separated it from *Spheniscus magellanicus*.

Mr Moseley gives the following graphic account of his visit to the breeding-place of this Penguin (Notes, p. 155, *et seq.*):—

"I paid a visit to an island in False Bay, called Seal Island. It is a mere shelving rock, on which it is only possible to land on very favourable occasions.

"The whole place is a rookery of the jackass Penguin (*Spheniscus demersus*). It is an ugly bird as compared with the crested Penguin of Tristan da Cunha; the bill is blunter, but the birds can nevertheless bite hard with it [all the Penguins seem to bite rather than peck]. The birds here nested on the open rock, which was fully exposed to the burning sun and occasional rain. It must not be supposed that either Penguins or Albatrosses are necessarily inhabitants of cold climates; a species of Penguin and an Albatross breed at the Galapagos Archipelago, almost exactly on the equator.

"There was not a blade of grass on the rock, but it was covered with guano, with little pools of filthy green water. The birds nested under big stones, wherever there was place for them. Most of the nests were, however, quite in the open. The nests were formed of small stones and shells of a *Balanus*, of which there were heaps washed up by the surf, and of old bits of wood, nails, and bits of rope, picked up about the ruins of a hut which were rotting on the island, together with an old sail, some boats' spars, and bags of guano, evidently left behind by guano-seekers. The object of thus making the nest is no doubt to some extent to secure drainage in case of rain, and to keep the eggs out of water washing over the rocks; but the birds evidently have a sort of magpie-like delight in curiosities. *Spheniscus magellanicus* at the Falkland Islands similarly collects variously coloured pebbles at the mouth of its burrow. Two pairs of the birds had built inside the ruins of the hut.

"All the birds fought furiously, and were very hard to kill. They make a noise very like the braying of donkeys, hence their name; they do not hop, but run or waddle. They do not leap out of the water like the crested Penguin when swimming, but merely come to the surface and sit there like ducks for a while, and dive again. We dragged off a number in the boat for stuffing, and took young and eggs; the old ones fought hard in the boat, and tried to bite one another's eyes out."

4. *Spheniscus magellanicus*, Forst. (Pl. XXVIII.).

*Aptenodytes magellanicus*, Forst., Nov. Comm. Gott., vol. iii. p. 143, tab. 5.
*Spheniscus magellanicus*, Scl., Proc. Zool. Soc., 1860, p. 382; Scl. et Salv., *Ibid.*, 1878, p. 653.
*Spheniscus demersus*, var. *magellanicus*, Coues, Proc. Ac. Phil., 1872, p. 209.

[No. 689. Male. Port Churrucha.

The only one seen. Eyes hazel; the stomach had many portions of fish, some of considerable size; upper part of the feet white; bill black or slate coloured.

No. 741. Young female. Falklands.

Eyes brown. Stomach had fish.]

The plate (XXVIII.) represents the two specimens collected.

In the Proceedings of the Academy of Sciences of Philadelphia for 1872, Dr Coues has written an excellent article upon the Spheniscidæ. But he appears to us to have been quite in error in classing this species as a variety of *Spheniscus demersus*, the two birds in adult plumage being, as will be seen from the accompanying figures, quite different in plumage.

Of *Spheniscus demersus* we have had many examples living in the Zoological Society's gardens, and the species is now well known to us. When adult they never fail to arrive at the plumage shown in Plate XXVII. The present species is of about the same size as *Spheniscus demersus*, and it might be perhaps not always easy to distinguish the young birds, such as is shown in Plate XXVIII. fig. 2. But in the adult of *Spheniscus magel-*

*lanicus* (Pl. XXVIII. fig. 1) the well-marked double black band on the breast renders the species at once recognisable.

Another quite distinct species that Dr Coues has united to *Spheniscus demersus* is *Spheniscus humboldti*, Meyen, of the coasts of Chili and Peru. This specimen has only one black band like *Spheniscus demersus;* but this band is much broader, while the white frontal band is much narrower. It is also considerably smaller in dimensions.

*Spheniscus humboldti.* (From Proc. Zool. Soc., 1879, p. 8.)

Mr Murray sends me the following notes on *Spheniscus magellanicus* :—

"We frequently saw these birds in the eastern parts of the Straits of Magellan, but always in the water. At the Falklands we found several rookeries. These birds burrow into both sandy and peaty banks. 'Sam,' our Newfoundland dog, dug out some of these nests fully 8 feet into the sand hills.

"In their stomachs were fish-bones, cuttlefish beaks, and pebbles. It is quite astonishing the number and size of the stones, shells, and pebbles which were noticed lying about the mouth of the burrows.

"The sealers told me that these birds when they come up from the sea vomit up these stones at the mouths of their burrows, and when they go to sea again they take in the very same stones as 'ballast.' The sealers say the fur-seals take in ballast in the same way as the Penguins."

5. *Eudyptes chrysolophus*, Brandt (Pl. XXIX.).

*Aptenodytes chrysocome*, Forst., Nov. Comm. Gott., vol. iii. p. 135.
*Catarractes chrysolophus*, Brandt, Bull. Ac. Pét., vol. ii. p. 315.
*Eudyptes chrysolophus*, Scl., Ibis, 1860, pp. 338, 432, et Proc. Zool. Soc., 1860, p. 390; Abbott, Ibis, 1861, p. 163; Sharpe, Zool. Kerg., p. 57; Scl. et Salv., Proc. Zool. Soc., 1878, p. 654.
*Eudyptes diadematus*, Gould, Proc. Zool. Soc., 1860, p. 419.

[*a–c*. Males.
*d*. Female.
*e*. Pale var. } Christmas Harbour, Kerguelen.]

On comparison of the Kerguelen specimens of this Penguin with others from the Falklands we find no reason for considering them otherwise than of the same species. There is, however, less appearance of the white upper tail-coverts in the Falklands specimens. Why Mr Sharpe should have referred *Eudyptes chrysolophus* (Sclater and Abbott) of the Falklands to *Eudyptes saltator* we cannot understand, nor can we appreciate the characters by which he separates his *Eudyptes saltator* from *Eudyptes chrysocome*.

Forster evidently had both the "Rock-hopper" and "Macaroni" Penguins under his eyes when he described his *Aptenodytes chrysocome*.[1] Brandt first clearly separated the two species, which are quite distinct and easily recognised by the characters which he has given.

The type specimen of *Eudyptes diadematus*, Gould, for which we have made every inquiry, is unfortunately no longer to be found. Mr Gould has parted with it, he knows not whither. It was *probably* only an individual variety of this species.

The plate represents an adult of this species (*c*), and the pale variety (*e*), both from Kerguelen.

I extract the subjoined account of the nesting of this Penguin at Kerguelen from Mr Moseley's Notes (p. 195):—

"On the talus slopes beneath the cliffs, along the whole south side of Christmas Harbour, are vast Penguin rookeries, the Penguins here nesting amongst the stones where vegetation is entirely wanting; and to the north of the harbour at its entrance are other similar rookeries. Towards the upper part of the harbour, the rookeries are those of the smaller crested Penguin, called 'Rock-hopper' by the sealers, the same as that at Marion Island; but nesting scattered amongst these is another kind of Penguin, *Eudyptes chrysolophus*, the Macaroni of sealers.

[1] He describes the crest "in aliis individuis in fronte unita, in aliis divisa" (*l. s. c.*, p. 137).

"This bird has a most beautiful golden crest, showing conspicuously on the middle of the upper part of the head, commencing just behind the beak, and with a plume on each side as in the bi-crested species. The bird is larger than the 'Rock-hoppers,' and is further distinguished from them by the presence of a naked, somewhat tumid space at the base of the beak, which is of a light pink colour. In other colouring the bird resembles the Rock-hoppers. This Penguin occurs at the Falkland Islands, where it nests, as at Kerguelen Island, in small quantities amongst the Rock-hoppers.[1]

"The birds, however, only thus nest amongst the other Penguins where they are few in number; towards the head of the harbour, and under the natural arch, they have enormous rookeries of their own, where, singularly enough, a few of the Rock-hoppers nest as guests amongst them; they have large rookeries also in Heard Island, where their eggs are gathered in large quantities by the sealers for eating."

Mr Murray sends me the following notes on this Penguin :—

"These birds were in immense numbers at Kerguelen. Their rookeries were generally situated on the outlying points of rocks and headlands. At Christmas Harbour the Rock-hoppers occupy the inner part of the south coast, and the Macaronis the outermost part of the shore, the two rookeries running one into the other. Occasionally one may find a few Macaronis nesting among the Rock-hoppers, and *vice versa*.

"Like the Rock-hoppers they had sometimes one and sometimes two young birds in a nest.

"The sealers told us that they usually laid three egs, but pitched the first two out of the nests for the Sheath-bills to eat; these first eggs were generally much smaller than the other eggs. We got some of these at the Falklands, where the sealers called them 'first year's' or 'virgin eggs.' The small eggs are probably the same as the small eggs found in the nests of the common Hen, Pheasant, Partridge, &c."

6. *Eudyptes chrysocome*, Forst. (Pl. XXX.).

*Aptenodytes chrysocome*, Forst., Nov. Comm. Gott., vol. iii. p. 135 (*partim*).
*Catarractes chrysocome*, Brandt, Bull. Ac. Pét., vol. ii. p. 314.
*Eudyptes chrysocome*, Scl., Proc. Zool. Soc., 1860, p. 390; Scl. et Salv., *Ibid.*, 1878, p. 654.
*Eudyptes nigrivestris*, Gould, Proc. Zool. Soc., 1860, p. 418.
*Eudyptes saltator*, Sharpe, Zool. Kerg., p. 60.

[*a–e*. Inaccessible Island.
*f*, *g*. Males. Kerguelen.
*h*, *i*. Adults. Christmas Harbour, Kerguelen.
*j*, *k*. Adults. Kerguelen.
*l*. Young. Kerguelen.
*m*, *n*. Males, in down. Falklands.
*o*. Young, in down. Falklands.]

[1] See Proc. Zool. Soc., 1865, p. 527.

On comparison of the series from these three localities we cannot satisfactorily recognise more than one species of Rock-hopper. The bird from Inaccessible Island has the elongated superciliary plumes more produced; those of the Falklands and Kerguelen have them rather shorter.

As regards the Australian and New Zealand bird (*Eudyptes pachyrhynchus* of Gray), to which Mr Sharpe proposes to restrict the name *chrysocome* of Forster, we likewise doubt its distinctness. The only differential characters given by Mr Sharpe consist in the relative lengths of the black and yellow feathers of the superciliary tufts. At the same time we should like to examine a series of this form before pronouncing a decided opinion on the point.

The plate (XXX.) represents an adult from Inaccessible Island (specimen *e*), and a specimen in down-plumage from the Falklands (*o*).

Mr Moseley gives us an excellent account of his observations on this Penguin at Inaccessible Island, where he landed on October 16, 1873 (Notes, p. 119, *et seq.*):

"It seems remarkable that there should be only one species of Penguin at the Tristan da Cunha group, since in most localities several species occur together.

"It would have seemed probable that a species of 'jackass' Penguin (*Spheniscus*) should occur on the islands, since one species (*Spheniscus megellanicus*) occurs at the Falkland Island and Fuegia, and another (*Spheniscus demersus*) at the Cape of Good Hope, intermediate between which two points Tristan da Cunha lies. The connection between these two widely separated *Sphenisci* is wanting; it perhaps once existed at Tristan and has perished.

"Most of the droves of Penguins made for one landing-place, where the beach surface was covered with a coating of dirt from their feet, forming a broad tract leading to a lane in the tall grass, about a yard wide at the bottom, and quite bare, with a smoothly-beaten black roadway; this was the entrance to the main street of this part of the 'rookery,' for so these Penguin establishments are called.

"Other smaller roads led at intervals into the rookery to the nests near its border, but the main street was used by the majority of the birds. The birds took little notice of us, allowing us to stand close by, and even to form ourselves into a group for the photographer, in which they were included.

"This kind of Penguin is called by the whalers and sealers Rock-hopper, from its curious mode of progression. The birds hop from rock to rock with both feet placed together, scarcely ever missing their footing. When chased they blunder and fall amongst the stones, struggling their best to make off.

"With one of the Germans as guide, I entered the main street. As soon as one was in it, the grass being above one's head, one was as if in a maze, and could not see in the least where one was going to. Various lateral streets lead off on each side from the main road, and are often at their mouths as big as it, moreover, the road sometimes

divides for a little and joins again; hence it is the easiest thing in the world to lose one's way, and one is quite certain to do so when inexperienced in Penguin rookeries. The German, however, who was our guide on our first visit, accustomed to pass through the place constantly for two years, was perfectly well at home in the rookery, and knew every street and turning.

"It is impossible to conceive the discomfort of making one's way through a big rookery, hap-hazard, or 'across country,' as one may say. I crossed the large one here twice afterwards with the seamen carrying my basket and vasculum, and afterwards went through a still larger rookery at Nightingale Island.

"You plunge into one of the lanes in the tall grass which at once shuts the surroundings from your view. You tread on a slimy, black, damp soil composed of the birds' dung. The stench is overpowering, the yelling of the birds perfectly terrifying, I can call it nothing else. You lose the path, or perhaps are bent from the first in making direct for some spot on the other side of the rookery.

"In the path only a few droves of Penguins, on their way to and from the water, are encountered, and these stampede out of your way into the side alleys. Now you are, the instant you leave the road, on the actual breeding ground. The nests are placed so thickly that you cannot help treading on eggs and young birds at almost every step.

"A parent bird sits on each nest, with its sharp beak erect and open ready to bite, yelling savagely 'caa, caa, urr, urr,' its red eye gleaming and its plumes at half-cock, and quivering with rage. No sooner are your legs within reach than they are furiously bitten, often by two or three birds at once—that is, if you have not got on strong leather gaiters, as on the first occasion of visiting a rookery you probably have not.

"At first you try to avoid the nests, but soon find that impossible; then maddened almost by the pain, stench, and noise, you have recourse to brutality. Thump, thump goes your stick, and at each blow goes a bird. Thud, thud, you hear from the men behind as they kick the birds right and left off the nests; and so you go on for a bit, thump and smash, whack, thud, 'caa, caa, urr, urr,' and the path behind you is strewed with the dead and dying and bleeding.

"But you make miserably, slow progress, and, worried to death, at last resort to the expedient of stampeding as far as your breath will carry you.

"You put down your head and make a rush through the grass, treading on old and young hap-hazard, and rushing on before they have time to bite.

"The air is close in the rookery, and the sun hot above; and out of breath, and running with perspiration, you come across a mass of rock fallen from the cliff above, and sticking up in the rookery; this you hail as 'a city of refuge.' You hammer off it hurriedly half a dozen Penguins who are sunning themselves there, and are on the look-out, and mounting on the top take out your hankerchief to wipe away the perspiration

and rest a while, and see in what direction you have been going, how far you have got, and in what direction you are to make the next plunge. Then when you are refreshed you make another rush, and so on.

"If you stand quite still, so long as your foot is not actually on the top of a nest of eggs or young, the Penguins soon cease biting at you and yelling. I always adopted the stampede method in rookeries; but the men usually preferred to have their revenge, and fought their way every foot.

"Of course, it is horribly cruel thus to kill whole families of innocent birds; but it is absolutely necessary. One must cross the rookeries in order to explore the island at all, and collect the plants, or survey the coast from the heights.

"These Penguins make a nest which is simply a shallow depression in the black dirt, scantily lined with a few bits of grass, or not lined at all. They lay two greenish-white eggs about as big as duck eggs, and both male and female incubate."

Six eggs from Inaccessible in the collection are of a uniform pale greenish-white, and measure 2·4 by 1·9 inches.

Mr Murray's notes on this Penguin are as follows:—

"We saw these birds at Tristan, at Inaccessible Island, and at Nightingale Island. In Inaccessible Island we found a Penguin rookery, over 3 acres in extent. It is situated on a flat to the north, covered with tall tussock-grass (*Spartina*), and about 14 feet above the level of the sea.

"The tussock-grass was from 7 to 8 feet high, and the Penguins' nests were situated about the roots of the clumps of grass. In 2 square yards I counted as many as six nests. At the times of our visit the birds were sitting on their eggs and young. Most frequently there was but one egg, but sometimes we found two.

"The nests were simply a slight hollow scraped in the dark earth at the base of the tufts of grass.

"On Nightingale Island we found a rookery which I estimated to cover from 40 to 50 acres. This was also situated chiefly on a flat covered with tall tussock-grass, and about 40 feet above the sea level. Some of the nests of the Penguins were situated fully 150 feet above the sea, and some of them were nearly one-quarter of a mile inland from the sea.

"In both these rookeries there were two or three main entrances from the sea. We did not see rookeries on Tristan, but we got some of the birds. All the birds on this Tristan group had the yellow superciliary plumes considerably longer than that of those got at Kerguelen and the Falklands. They also all seemed to me rather bigger birds. The Tristan birds are, I think, a well-marked variety. Their stomachs had remains of crustaceans, and occasionally fish.

"At the Falklands and at Kerguelen we found the rookeries along the shores among rocks, and at the latter island in vast numbers. During our visit at Kerguelen (all January 1874) they were sitting on their eggs and young. We put one of these birds in

a fish-basket and placed it just under water, it was drowned, dead, in one minute and thirty seconds. At Kerguelen we found in their stomachs *Serolis*, copepods, amphipods, and occasionally some remains of fish. Most frequently there was but one young in the nest, occasionally two.

"The Germans at Tristan told us these birds came on shore for breeding in July and August, and that the males came a week or two before the females.

"In December both old and young leave for sea. A few weeks later they return for moulting, and remain on land till April, spreading all over the island. On the Falklands I was told by the sealers that these Rockeys come on shore for breeding about the end of October, and in February and March they moult after the young birds are all hatched. These sealers said these birds were seen in numbers off the mouth of the Plate in the months of June and July. During our cruise we seldom noticed Penguins far away from sand or ice—that is to say, over 40 or 50 miles from land.

"The sealers say the King and Johnny never go far out to sea."

The following is a list of the Penguins met with by the Challenger at the five breeding-places in the South Atlantic and Indian Ocean which they visited. I have not referred to the Falklands, because the Penguins of these groups, and their habits, have been previously well described by a resident observer.[1] Of the species marked with an asterisk, specimens were actually obtained at the localities named; the others are mentioned as having occurred by Mr Moseley.

1. Tristan da Cunha group,
   - *a.* Inaccessible Island. October 1873,
   - *b.* Nightingale Island. October 1873,

   * *Eudyptes chrysocome.*
2. Cape of Good Hope, Seal Island. November 1873,

   * *Spheniscus demersus.*
3. Marion Island, Prince Edward group. December 26, 1873,
   - * *Aptenodytes longirostris.*
   - *Pygosceles tæniatus.*
   - *Eudyptes chrysocome.*
4. Kerguelen Island. January 1874,
   - * *Aptenodytes longirostris.*
   - * *Pygosceles tæniatus.*
   - * *Eudyptes chrysolophus.*
   - * *Eudyptes chrysocome.*
5. Heard Island. February 1874,
   - *Pygosceles tæniatus.*
   - *Eudyptes chrysolophus.*

[1] Capt. C. C. Abbott. See Ibis, 1860, p. 336.

## X.—*On the Laridæ collected during the Expedition.* By Howard Saunders, F.L.S., F.Z.S.

(Reprinted from the Proceedings of the Zoological Society of London, 1878.)

At the request of Mr Sclater, I have undertaken with much pleasure the determination of the Laridæ collected during the expedition of H.M.S. Challenger, amounting in all to 47 specimens. It was hardly to be expected that amongst these any previously undescribed species would be found; but in consequence of the careful manner in which the specimens have been catalogued and labelled by Mr John Murray, many of them are of great value in increasing our knowledge of the geographical distribution of the Oceanic birds. It is highly desirable that more attention should be devoted to this subject, instead of being limited, as is so often the case, to land-birds only; and of the results which would probably reward such attention we may judge from the present small collection, which contains examples of 9 species, represented by 31 specimens, of Terns (*Sterninæ*), of 5 species, represented by 11 specimens, of Gulls (*Larinæ*), and of 3 species, represented by 5 specimens, of Skua gulls (*Stercorariinæ*); total 17 species, 47 specimens. Of these species, five have been obtained in absolutely new localities (three of them from places where they could hardly be expected to occur), whilst many of the other species derive unusual interest from the fact of their range being restricted to such seldom-visited spots as the rocks and islands of the South Atlantic. On the whole this collection of Laridæ, although small in numbers, is one of the most productive of knowledge which has yet been made by any of our national expeditions.

1. *Hydrochelidon hybrida*, Pallas.

*Sterna hybrida*, Pall. Zoogr. Rosso-As., vol. ii. p. 338, 1811.
*Hydrochelidon hybrida*, Gray, Gen. B., vol. iii. p. 660; Saunders, Proc. Zool. Soc., 1876; et 1877, p. 794.

[No. 364, ♀. Manila. 11th to 14th January 1875. Eyes black; feet dark red. Stomach had crustacea.]

A nearly adult specimen, the head being slightly streaked with black.

2. *Sterna virgata*, Cabanis.

*Sterna virgata*, Cabanis, J. f. Orn., 1875, p. 449; Saunders, Proc. Zool. Soc., 1876, p. 646, et 1877, p. 794.

[One specimen marked X on label.
One specimen marked Θ on label.] Christmas Harbour, Kerguelen Island.

One specimen. Christmas Harbour, Kerguelen Island.

One specimen. Betsy Cove, Kerguelen Island.]

The first is nearly adult; but the black head is not yet fully assumed, and the bill and feet are still reddish-black; in the second the black head only is wanting to complete the nuptial dress; but the third is in full breeding plumage, as is also a specimen in spirits.

The specimen from Betsy Cove is a young bird just fledged, many particles of down still adhering; general colour sooty grey mottled with brown, and barred with black on the upper parts; under-wing coverts white.

This somewhat specialised form has hitherto been only found at Kerguelen Island, and appears to be more closely allied to the New Zealand species *Sterna antarctica*, Wagler, than to the less restricted form *Sterna vittata*, which also includes in its range portions of the same island. The principal specific distinctions of the two species are given in my paper on the Sterninæ above referred to.

[Large flocks of this Tern hovered over the beach as we first landed at Christmas Harbour, were dipping down into the ripples, and picking up something, which was apparently a little red copepod, the dead bodies of which formed a long line left by the retiring tide.]

3. *Sterna vittata*, Gm.

*Sterna vittata*, Gm., Syst. Nat., vol. i. p. 609 (1788); Saunders, Proc. Zool. Soc., 1876, p. 647, et 1877, p. 795.

[One specimen. Inaccessible Island, Tristan da Cunha, 18th October 1873.

One specimen. Royal Sound, Kerguelen Island, January 1874.]

Both these specimens are adults in breeding-plumage; but the latter is not a very old bird, the outer webs of the long tail-feathers being still slightly tinted with grey, whereas in really mature examples they are long and white. In pointing out its specific characters (*l. s. c.*), I gave its then known range as from Kerguelen Island up to St Paul's and Amsterdam Islands, about 700 miles to the north, apparently its headquarters, and as that of a straggler over the sea between St Helena and Ascension; but the fact of its having been obtained close to Tristan da Cunha is an interesting extension of these limits. When treating of the few examples then available from the above-mentioned localities, I remarked that the affinities of this species were decidedly with *Sterna hirundinacea*, Lesson (*Sterna cassini*, Scl.), of the extra-tropical coasts of South America and of the Falkland Islands; and this view has subsequently been confirmed by the examination of a larger series brought home by the French naturalists from the Transit-of-Venus Expedition, at the same time that the two species are always perfectly distinguishable. But in the case of this individual from Tristan da Cunha (its nearest known approach to South America), it is interesting to observe that, although the example is undoubtedly referable to *Sterna*

*vittata* and not to *Sterna hirundinacea*, it comes nearer to the latter species than any other specimen yet examined. However, its relatively smaller size, grey colour, and the characteristic shortness of the foot and claws show distinctly that the bird in question is *Sterna vittata*; and although it has a rather unusually long bill, yet there is an absence of the long curve characteristic of the American bird. It may be remarked that the bill in individuals of the present species seems to be peculiarly brittle and friable, which will account for the worn and blunted appearance often to be observed in the anterior portions of the mandibles.

There are the remains of an egg, labelled as taken at Heard Island, February 1874, which evidently belongs to either *Sterna virgata* or *Sterna vittata*; I incline to attribute it to the former, owing to its size and dull appearance.

4. *Sterna hirundinacea*, Lesson.

*Sterna hirundinacea*, Lesson, Tr. d'Orn., p. 621, 1831; Saunders, Proc. Zool. Soc., 1876, p. 647; et 1877, p. 796.

[No. 652, ♂. Messier Channel, Straits of Magellan, 4th January 1876. Eyes black; bill and legs vermilion.

No. 723, ♂. } Elizabeth Island, Straits of Magellan, 18th and 19th January 1876.
No. 724, ♀. } Eyes black; bill and legs red. Stomach had fish. A number of eggs were preserved, there being a large "rookery" at one of the low points of this island.]

Three fine and fully adult specimens of this well-known South American species. Sixteen eggs from this locality are naturally rather larger than the type of those of *Sterna fluviatilis* or *Sterna macrura*; but otherwise they merely exhibit the same variations in markings.

5. *Sterna bergii*, Licht.

*Sterna bergii*, Licht., Verz. Doubl., p. 80, 1823; Saunders, Proc. Zool. Soc., 1876, p. 657, et 1877, p. 796.

[No. 77, ♂. Levuka, Fiji, 30th July 1874. Eyes black; feet black, soles brown.] Nearly adult.

[No. 231, ♀. Dobbo, Arrou Islands, 16th and 17th September 1874. Eyes black; feet black; bill light yellow.]

A bird of the year.

[No. 345, ♂. Samboangan, Philippine Islands, 24th October 1874. Eyes black.]

Nearly adult, but in winter plumage, the head being merely striated and not black.

[No. 486, ♂. Nares Harbour, Admiralty Islands, 3d to 10th March 1875. Eyes black.]

Adult, with the black head and crest, and the white frontlet band characteristic of the breeding-plumage.

6. *Sterna fuliginosa*, Gm.

*Sterna fuliginosa*, Gm., Syst. Nat., vol. i. p. 605, 1788; Saunders, Proc. Zool. Soc., 1876, p. 666, et 1877, p. 696.

[One specimen ♀. Boatswain-bird Island, Ascension Island, about April 4, 1873.

No. 124, ♀. } Raine Island, Barrier
No. 125, ♂. } Reef, Australia, . { Eyes, bill, and feet black. Stomach of first contained a cuttlefish and a piece of coral; that of second, nothing. In great numbers. Eggs rounded and more spotted than those of the Noddy.]

Fifteen eggs of this species from Raine Island form a very fine series.

These three specimens are in adult breeding plumage, the long outer tail-streamers being, however, somewhat abraded.

7. *Gygis candida*, Gm.

*Sterna candida*, Gm., Syst. Nat., vol. i., 2, p. 607, 1788.
*Gygis candida*, Wagler, Isis, 1832, p. 1223; Proc. Zool. Soc., 1876, p. 667, et 1877, p. 797.

[Two specimens, ♂ and ♀. Boatswain-bird Island, Ascension Island, about April 3, 1876.

No. 546, ♀ } Tahiti, September 18 to October 2, 1875. Shot by Balfour on trees near
No. 547, ♀ } Papuerini? Eyes black.]

These are two specimens in spirits.

All these examples have bills broad at the base, although from the mandibular angle to the tip there is some slight variation, those of the Tahitian birds being more pointed, whilst in those from the volcanic crags of Boatswain-bird Island the bill is evidently worn down and blunted. In the coloration of the webs of the feet, also, the Tahitian birds are of a brighter lemon-colour; but the extent of this colour is the same in all, viz., down to and a little below the last joint of the middle toe. The shafts of the tail-feathers and of the primaries seem liable to become white with the age of the feather itself, owing to abrasion of the surface; but in no case are the characteristics wanting which distinguish this species from *Gygis microrhyncha*, only known at present from the Marquesas Islands, where the present species is also found. The fact of its being obtained near Ascension Island is an interesting addition to our knowledge of its range, as it has not yet been recorded on that side, so far as I am aware, beyond St Helena.

8. *Anous stolidus*, Linn.

*Sterna stolida*, Linn., Syst. Nat., vol. i. p. 227, 1766.
*Anous stolidus*, Gray, List. Gen. Birds, p. 100, 1841; Saunders, Proc. Zool. Soc., 1876, p. 669, et 1877, p. 797.

[Two specimens. Inaccessible Island, near Tristan da Cunha, October 16, 1873. Eyes black. Shot sitting on branches of a tree (*Thylica arborea*).

No. 140, ♂. Raine Island, Australia. Feet, bill, and eyes black.

No. 444, ♀. At sea; lat. 1° N., long. 137° 11′ E.

No. 485, ♀. Admiralty Islands, March 3–10, 1875.

No. 564, ♂. At sea, near Tahiti, October 1875.]

In alcohol. Egg, and newly hatched young, St Paul's Rocks, Atlantic, August 28, 1873.

Nine eggs from Raine Island, August 31, 1874.

This is a very interesting series, showing the changes resulting from age, both in the individual and in the annual plumage. The examination of a great number of Noddies from various localities tends to show that specimens in clean and fresh plumage are very rarely to be met with; and the weatherworn appearance of some individuals, when compared with freshly moulted birds, would lead the superficial observer to suppose that he had before him distinct species. The example, No. 564, is an instance of this, it being a superb old bird, freshly moulted, with all the edges of the feathers perfect, the crown of the head of a pale lavender, and with much smoke-colour on the throat, neck, and breast; the primaries and tail-feathers like satin, and having in some cases not quite attained their full length; altogether the finest specimen of the common Noddy I ever saw. Both this and the next species are described in Mr Murray's journal as being very abundant at the Admiralty Islands, hovering in immense numbers over shoals of fish. That the general range of these species is intertropical is tolerably well known; but it is somewhat surprising to find both this and *Anous melanogenys* at Inaccessible Island, close to Tristan da Cunha, in 37° S. latitude, on the peculiar domain of the Albatross and the Penguin. The two examples of *Anous stolidus* from there are absolutely identical with specimens from the Tortugas; and I can find no reason for attributing any of the larger form to other than this species.

9. *Anous melanogenys*, Gray.

*Anous melanogenys*, G. R. Gray, Gen. Birds, vol. iii. p. 661, pl. clxxxii., 1842; Saunders, Proc. Zool. Soc., 1876, p. 670, et 1877, p. 798.
*Anous tenuirostris*, mult. auctorum, nec Temm.

[In alcohol. Adult, young in down, and egg. St Paul's Rocks, Atlantic Ocean.

One specimen. St Paul's Rocks, August 27, 1873.

One specimen. Inaccessible Island, Tristan da Cunha, October 16, 1873. Shot sitting on the branches of a tree (*Phylica arborea*).

No. 484, ♀. Admiralty Islands, March 3 and 10, 1875.

No. 508, ♀. At sea, March 20, 1875. Stomach contained small crustacea. Eyes black.]

In the adult specimen from St Paul's rocks, where the breeding-season was far advanced, the feathers are much worn; and the bird from Inaccessible Island appears to be only a few months old, the portion of the bill in front of the mandibular angle being very short and weak. Under the head of the preceding species I have already remarked upon the noteworthy fact of these two Noddies being found so far south, and it would be interesting to know if they breed there. The specimens from the Admiralty Islands are adults.

10. *Larus ridibundus*, Linn.

*Larus ridibundus*, Linn., Syst. Nat., vol. i. p. 225, 1766; Saunders, Proc. Zool. Soc., 1877, p. 798.

[No. 363, ♂. Manila, January 11 and 14, 1875. Eyes brown.

Four specimens, two ♂, two ♀. Yokohama, Japan, May 1875. Eyes brown.]

The Manila specimen and two of the Japanese are birds of the previous year, the other two are adults. One of these, a female, is remarkable for its small size, the wings (allowing for a deficient primary) being only 11·5 inches long; still I have seen and possessed similar examples of diminutive females from other localities, as well as from Japan and China; and the other parts being in proportion, there is nothing else to distinguish this from the ordinary form.

11. *Larus canus*, Linn.

*Larus canus*, Linn., Syst. Nat., vol. i. p. 224, 1766; Saunders, Proc. Zool. Soc., 1877, p. 799.

[♂. Japan, May 1875.]

A bird of the previous year; wing-coverts much abraded.

12. *Larus glaucodes*, Meyen.

*Larus glaucodes*, Meyen, Obs. Zool., p. 115, pl. xxiv., 1834; Scl. and Salv., Proc. Zool. Soc., 1871, p. 578; Saunders, *Ibid.*, 1877, p. 799.

[No. 650, ♂. Messier Channel, Straits of Magellan, January 4, 1876. Eyes hazel, feet and bill reddish.]

A bird of a full year old, the tail being nearly devoid of the band showing immaturity; but the shoulders retain some brownish feathers.

Two eggs presented by Mr Deans, of Stanley, Falkland Islands, marked "Tern Gull" appear to belong to this species, which is a well-known breeder in that group.

13. *Larus novæ-hollandiæ*, Steph.

*Larus novæ-hollandiæ*, Steph., in Shaw's Gen. Zool., vol. xiii. part 1, p. 169, *ex* Lath., 1825; Saunders, Proc. Zool. Soc., 1877, p. 799.
*Larus jamesoni*, Wils., Ill. Orn., pl. xxiii. et descript., 1831.

[No. 131, ♂. } Raine Island, North Australia. Eyes white; bill coral, tip darker.
No. 132, ♀. } Only a few about the island.]

From its large size and the difference in the amount of white on the primaries of the adults, this form seems to be fairly separable from *Larus scopulinus*, of New Zealand, and is undoubtedly distinct from its ally, *Larus hartlaubi*, Bruch, of the Cape of Good Hope. Specimens from the northern portions of Australia are much wanted; and these two examples are therefore of unusual value.

14. *Larus dominicanus*, Licht.

*Larus dominicanus*, Licht., Verz. d. Doubl., p. 82, 1823; Saunders, Proc. Zool. Soc., 1877, p. 799.

[One specimen. Christmas Harbour, Kerguelen Island.
No. 683, ♂. Nassau Harbour, Straits of Magellan, January 11 to 13, 1876. Eyes grey; bill yellow; angle of lower mandible red.]

Two adult specimens. I can detect no specific difference between the examples of this form, which ranges from New Zealand to South Africa, and thence to the extra-tropical portions of South America.

One egg from Kerguelen Island. } The latter partake rather more of the bold markings
Two eggs from Elizabeth Island, Straits of Magellan. } characteristic of the eggs of *Larus maridus* than the former.

15. *Stercorarius antarcticus*, Less.

*Lestris antarcticus*, Less., Traité d'Orn., p. 616, 1831.
*Stercorarius antarcticus*, Saunders, Proc. Zool. Soc., 1876, p. 321, et 1877, p. 799.

[One specimen. Inaccessible Island, Tristan da Cunha, October 16, 1873.
One specimen. Christmas Harbour, Kerguelen Island, January 1874.
No. 732, ♀. Falkland Islands, January to February 1876. Eyes hazel.]

The two former are of the usual dusky colour; the last shows the pale yellow acuminate feathers on the collar, which are rarely absent in specimens from the Falklands.

[At Nightingale Island, in October, these Skuas were observed to light on trees; one or two nests had eggs. At Kerguelen (January) all the nests had young, and we saw no eggs.]

16. *Stercorarius chilensis*, Bp.

*Lestris antarcticus*, var. c. *chilensis*, Bp., Consp. Av., vol. ii. p. 207, 1857.
*Stercorarius chilensis*, Saunders, Proc. Zool. Soc., 1876, p. 313, et 1877, p. 800.

[No. 718, ♂. Elizabeth Island, Straits of Magellan, January 18, 1876. Eyes brown. Stomach had fish, &c.]

A freshly moulted but somewhat immature specimen. Hitherto no examples of this well-marked form have been obtained beyond the eastern exit of the Straits of Magellan, its range being apparently to the westward and northward along the coast as far as the lat. 23° S. Since writing my notice of the *Stercorariinæ* (*loc. cit.*), I have had an opportunity of verifying the correctness of my opinions by the examination of Bonaparte's type in the Berlin Museum.

17. *Stercorarius pomatorhinus*, Temm.

*Lestris pomarinus*, Temm., Man. d'Orn., p. 514, 1815.
*Stercorarius pomatorhinus*, Newton, Ibis, p. 509, 1865; Saunders, Proc. Zool. Soc., 1876, p. 324, et 1877, p. 800.

[One specimen. Off Inosima, Japan, May 1875.]

A very fine adult bird; the golden tips to the feathers on the sides of the neck being very rich, and the dusky pectoral band being faint in the centre. This is quite a new locality for this species; for although its occurrence as a straggler once on the coast of Tenasserim, and once at Cape York, North Australia, would lead to the expectation that it would find its way downwards through the North Pacific, yet the only other locality on that side hitherto recorded is that of the Prybilov Islands, a long way to the N.W. The date, and the fact of this specimen being an adult, make this link in the chain of our knowledge of its geographical distribution particularly interesting.

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## XI.—*On the Procellariidæ collected during the Expedition.* By Osbert Salvin, M.A., F.R.S., &c.

(Reprinted from the Proceedings of the Zoological Society of London, 1878.)

Eighty specimens of *Procellariidæ* are comprised in the Challenger collection, belonging to twenty-two species and thirteen genera. The greater part of these were

obtained during the visit to Kerguelen Island; others were secured at sea in the South Pacific Ocean, a few near the Straits of Magellan, at Nightingale Island, and elsewhere. None of the species present any difficulty as regards their nomenclature; but I take this opportunity of adding a few notes on this subject, gathered during recent study of the species to which they belong.

1. *Oceanites oceanicus*, Kuhl.

*Procellaria oceanica*, Kuhl, Beitr., p. 136, pl. x. fig. 1.
*Oceanites oceanica*, Coues, Pr. Ac. Phil., 1864, p. 82; Salv., Orn. Misc., vol. ii. p. 227; et Proc. Zool. Soc., 1878, p. 735.

[*a–c*. Males. } Ice Barrier, February 14, 1874.]
*d*, *e*. Females. }

2. *Fregetta grallaria*, Vieill.

*Procellaria grallaria*, Vieill., N. Dict. d'Hist. N., vol. xxv. p. 418.
*Fregetta grallaria*, Bp., Consp., vol. ii. p. 197; Coues, Pr. Ac. Phil., 1864, p. 86; Salv., Proc. Zool. Soc., 1878, p. 735.
*Thalassidroma leucogastra*, Gould, Ann. and Mag. Nat. Hist., vol. xiii. p. 367, et B. Austr., vol. ii. pl. lxiii.

[Nos. 568–571. Females. } South Pacific, November 11, 1875.
Nos. 572, 573. Male. }

Eyes brown. Their stomachs were filled with a yellow oil, and mixed with it some pieces of Crustacea.]

I am strongly disposed to add to the above synonyms *Thalassidroma gracilis*, Elliot, Ibis, 1859, p. 391, and *Thalassidroma segethi*, Phil. and Landb., Arch. f. Naturg., 1860, names admitted by many authors to apply both of them to a species found on the Chilian coast. I have seen specimens of the present species in the Paris Museum from the same locality; and the Challenger specimens now before me were obtained at sea at no great distance from the same shore, so that on geographical grounds their identity is a reasonable supposition. The chief, if not the only discrepency I can find between the description of *Fregetta gracilis* and *Fregetta grallaria* is one of dimensions, the former being considerably smaller (as shown by Mr Elliot's measurements) than the Challenger birds. Thus we have:—

| | Wing. | Tarsus. | Tail. |
|---|---|---|---|
| | in. | in. | in. |
| *Fregetta gracilis*, . . . . . | 5·22 | 2·40 | 1·20 |
| *Fregetta grallaria*, . . . . . | 5·9–6·3 | 2·9–3·0 | 1·3–1·4 |

*Thalassidroma segethi* seems to be intermediate in dimensions; but so far as the description goes, its identity with *Fregetta grallaria* is obvious.

Mr Sharp (Zool. Kerg., Aves, p. 31) suggests that *Procellaria leucogastra* may prove to be a stage of plumage of *Procellaria melanogaster*; but I cannot think that this will ever turn out to be the case.

3. *Fregetta melanogastra*, Gould.

*Thalassidroma melanogastra*, Gould, Ann. and Mag. Nat. Hist., vol. xiii. p. 367, et B. Austr., vol. vii. pl. lxii.
*Fregetta melanogastra*, Salv., Proc. Zool. Soc., 1878, p. 736.

[*a*. Betsy Cove, Kerguelen.]

Mr Sharpe (Zool. Kerg., Aves, p. 30) unites *Thalassidroma tropica*, Gould, with this bird, and calls it by the last-mentioned name. They may be identical; but in any case the adoption of the name *tropica* in place of *melanogastra* cannot be justified, as the latter, having been in use for over thirty years, ought not to be supplanted by the former, the two having been published simultaneously on opposite pages of the same publication.

4. *Pelagodroma marina*, Lath.

*Procellaria marina*, Lath., Ind. Orn., p. 410.
*Pelagodroma marina*, Salv., Orn. Misc., vol. ii. p. 228; Proc. Zool. Soc., 1878, p. 736.

[*a–c*. Nightingale Island.

Eyes black; a night-bird. These Petrels were taken out of holes in the ground during the day by help of the dogs.]

5. *Thalassœca glacialoides*, Smith.

*Procellaria glacialoides*, Smith, Ill. Zool. Soc. Afr., pl. li.
*Thalassœca glacialoides*, Coues, Pr. Ac. Phil., 1866, p. 30; Salv., Proc. Zool. Soc., 1878, p. 736.

[*a*. Male. Ice Barrier. February 23, 1874.

These Petrels were only seen in the neighbourhood of the Antarctic Ice, and in small numbers, in company with *Thalassœca antarctica* and *Pagodroma nivea*.]

6. *Thalassœca antarctica*, Gaim.

*Procellaria antarctica*, Gaim., Syst. Nat., vol. i. p. 565.
*Thalassœca antarctica*, Coues, Pr. Ac. Phil., 1866, p. 31; Salv., Proc. Zool. Soc., 1878, p. 737.

[*a*. Male. Ice Barrier. February 14, 1874.
*b*. Male.
*c*, *d*. Females. } Ice Barrier. February 14, 1874.

Very numerous about the ships when south of 60° S. long., and near the Antarctic ice. Often seen sitting on the icebergs.]

7. *Adamastor cinereus*, Gm.

*Procellaria cinerea*, Gm., Syst. Nat., vol. i. p. 563.
*Adamastor cinereus*, Coues, Pr. Ac. Phil., 1864, p. 119; Salv., Proc. Zool. Soc., 1878, p. 737.

[No. 565. Female. } South Pacific. November 5, 1875.
No. 566. Male. }

Eyes hazel; feet flesh colour. The stomach of one was full of the beaks of Cuttle-fish; stuff from the ship in the other, and small crustacea.

These Petrels are also called Mutton-birds by sailors and sealers, and are confounded with *Œstrelata lessoni*.]

8. *Majaqueus æquinoctialis*, Linn.

*Procellaria æquinoctialis*, Linn., Syst. Nat., vol. i. p. 213.
*Majaqueus æquinoctialis*, Coues and Kidder, Bull. U. S. Nat. Mus., No. 2, p. 25; Sharpe, Zool. Kerg., Birds, p. 19; Salv., Proc. Zool. Soc., 1878, p. 737.

[*a–d*. Males. } Kerguelen.
*e*. Female. }

This bird and *Ossifraga gigantea* are both called by the sailors and sealers 'Cape-hero.' The present species is also called the 'Black Night-hawk.' It makes its nest under large round dome-like masses of *Azorella*.

We dug these birds out of their nests at almost every place where we landed in Kerguelen. There was always one egg only.]

9. *Ossifraga gigantea*, Gm.

*Procellaria gigantea*, Gm., Syst. Nat., vol. i. p. 563.
*Ossifraga gigantea*, Coues, Pr. Ac. Phil., 1866, p. 32; Salv., Proc. Zool. Soc., 1878, p. 737.

[No. 567. Female. South Pacific, November 7, 1875.

Bill yellowish green; feet black.

*a*. Betsy Cove, Kerguelen.

This bird is called 'Nelly' and 'Stinker' by the whalers at Kerguelen. It feeds largely on carrion. When the sea-elephants were being skinned at Betsy Cove, numbers of them collected to feed on the blubber.

We saw this Petrel from 31° S. lat., to the furthest south obtained, but never found it breeding.]

10. *Pagodroma nivea*, Gm.

*Procellaria nivea*, Gm., Syst. Nat., vol. i. p. 562.
*Pagodroma nivea*, Coues, Pr. Ac. Phil., 1866, p. 160; Salv., Proc. Zool. Soc., 1878, p. 737.

[*a*, *b*. Females. Ice Barrier. February 14, 1874.
Only seen south of 60° S. lat., near the Antarctic ice, and often sitting on the ice-bergs. Sometimes great numbers followed the ship.]

11. *Daption capensis*, Linn.

*Procellaria capensis*, Linn., Syst. Nat., vol. i. p. 213.
*Daption capensis*, Coues, Pr. Ac. Phil., 1866, p. 163; Salv., Proc. Zool. Soc., 1878, p. 737.

[*a*. Antarctic Sea. April 1874.
This bird is found all over the southern and Antarctic Oceans. It was abundant about the Antarctic ice.]

12. *Œstrelata lessoni*, Garn.

*Procellaria lessoni*, Garn., Ann. Sc. Nat., 1826, vol. vii. p. 54.
*Œstrelata lessonia*, Coues, Pr. Ac. Phil., 1866, p. 142; Coues and Kidd., Bull. U. S. Nat. Mus., No. 2, p. 27; Sharpe, Zool. Kerg., Birds, p. 26; Salv., Proc. Zool. Soc., 1878, p. 737.

[*a*, *b*. Males. Betsy Cove, Kerguelen.
*c*–*f*. Females. Betsy Cove, Kerguelen.
Eyes black.
This is the Mutton-bird or White Night-hawk of the whalers. It builds under large clumps of *Azorella*, like *Majaqueus æquinoctialis*, and generally has similar habits. In the nest is one white egg. In the stomach beaks of cuttle-fishes are usually found. We did not notice it south of Heard Island.]

During a recent visit to the Paris Museum I had an opportunity of examining the type of *Œstrelata sericea*, concerning which I had occasion to publish some notes in the Ibis for 1875 (p. 373). On seeing this type I at once recognised a specimen of *Œstrelata lessoni!* *Œstrelata sericea* (Less.), placed in the genus *Adœmastor* by Bonaparte and Coues, has therefore no existence as a species distinct from *Œstrelata lessoni*.

13. *Œstrelata mollis*, Gould.

*Procellaria mollis*, Gould, Ann. and Mag. Nat. Hist., vol. xiii. p. 363.
*Œstrelata mollis*, Coues, Pr. Ac. Phil., 1866, p. 150; Salv., Proc. Zool. Soc., 1878, p. 738.

[*a*, *b*. Nightingale Island. October 17, 1875.
Eyes hazel. Night bird.]

14. *Œstrelata brevirostris*, Less.

*Procellaria brevirostris*, Less., Man. d'Orn., vol. ii. p. 611.
*Œstrelata brevirostris*, Salv., Orn. Misc., vol. ii. p. 235; Proc. Zool. Soc., 1878, p. 738; Sharpe, Zool. Kerg., Birds, p. 24.
*Œstrelata kidderi*, Coues, Bull. U. S. Nat. Mus., No. 2, p. 28.

[*a*. Young. Kerguelen.]

The species included in Cabanis and Reichenow's paper on the Birds collected by the "Gazelle" (J. f. Orn., 1876, p. 329), under the name *Procellaria mollis*, belongs here. Last year I examined in Berlin the specimen brought home by the "Gazelle," and found it to be of this species.

The Challenger specimen is quite young, but interesting, as showing that these birds moult at once from the downy plumage into the feathering of the adult bird.

15. *Prion desolatus*, Gm.

*Procellaria desolata*, Gm., Syst. Nat., vol. i. p. 562.
*Prion desolatus*, Gray, H.-list., vol. iii. p. 108; Sharpe, Zool. Kerg., Birds, p. 37 (excl. syn.); Salv., Proc. Zool. Soc., 1878, p. 738.
*Pseudoprion desolatus*, Coues, Bull. U. S. Nat. Mus., No. 2, p. 32.

[*a*. Male. Betsy Cove, Kerguelen.
Obtained January 11, 1874. Eyes black.
*b–e*. Males. Betsy Cove, Kerguelen. Eyes black.
*f*. Female. Ice Barrier.
Obtained on February 14, 1874.
*g*, *h*. Females. Betsy Cove, Kerguelen.
We found nests of this species under almost every tuft of *Azorella* at Kerguelen. They contained one egg.]

Of the eight specimens of this species brought home by the Expedition, five are males and three females. They thus offer an opportunity of testing the view advanced by Mr Sharpe as to the supposed sexual difference in the size of the bill existing in these birds.[1]

In these specimens there is no tangible difference between the bills of the sexes; and as the opposite sexes of *Prion banksi*, as shown by the two Challenger specimens, are also alike as regards the size of the bills, doubts may fairly be raised whether the great difference observable in the size of the bills in these birds is a sexual character at all.

[1] Latham seems to have been the first author who mentioned this supposed sexual difference in *Prion*. After describing *Prion vittatus* (Syn., vol. iii. p. 414), he adds:—"The female has the same plumage; but the bill, though greatly exceeding that of any other Petrel, is scarcely more than half the breadth of that of the male."

16. *Prion banksi*, Smith.

*Pachyptila banksi*, Smith, Ill. Z. S. Afr., Birds, pl. lv.
*Pseudoprion banksi*, Coues, Pr. Ac. Phil., 1866, p. 166.
*Prion banksi*, Salv., Proc. Zool. Soc., 1878, p. 739.

[*a* Male. Marion Island.
Eyes brown.
*b*. Female. Caught at sea near Crozets.]

Without attempting to decide the question as to how many species of *Prion* exist, I use the name *Prion banksi* for these birds, as their bills agree most nearly with that of the type of *Prion banksi* in the British Museum.

17. *Pelecanoides urinatrix*, Gm.

*Procellaria urinatrix*, Gm., Syst. Nat., vol. i. p. 560.
*Pelecanoides urinatrix*, Coues, Pr. Ac. Phil., 1866, p. 190; Sharpe, Zool. Kerg., Birds, p. 14; Salv., Proc. Zool. Soc., 1878, p. 739.

[*a*. Male. Kerguelen.
Eyes dark grey.
*b*. Male. Betsy Cove, Kerguelen. Obtained January 1874.
*c*. Male. Christmas Harbour, Kerguelen.
*d*. Male. Betsy Cove, Kerguelen.
*e–h*. Females. Kerguelen.
*i*. Kerguelen.
*j*. Young. Kerguelen (?)

Called 'Horse-fart' by the whalers at Kerguelen, and builds its nest under the *Azorella* clumps, like the *Prion*.]

18. *Pelecanoides garnoti*, Less.

*Puffinuria garnoti*, Less., Voy. Coq. Zool., pl. xlvi.
*Pelecanoides garnoti*, Coues, Pr. Ac. Phil., 1866, p. 190; Salv., Proc. Zool. Soc., 1878, p. 739.

[No. 639. Female.
No. 640. Male (?) } Cove Harbour, Messier Channel.

Eyes hazel. These birds and another one which was put in spirit were found dead. Two were picked up by the boat in which Captain Maclear and I went, floating on the surface of the water; and the third was picked up by the galley on the rocks. They were quite fresh; the bodies were very thin.

Their stomachs were filled with small leaves. It looks very much as if these birds had got out of their region. Mr Moseley says he saw what he supposed to be one of these birds on Penguin Island.]

19. *Diomedea exulans*, Linn.

*Diomedea exulans*, Linn., Syst. Nat., vol. i. p. 214; Coues, Pr. Ac. Phil., pp. 175, 866; Coues and Kidder, Bull. Nat. Mus., No. 2, p. 11; Sharpe, Zool. Kerg., Birds, p. 45; Salv., Proc. Zool. Soc., 1878, p. 740.

[No. 574. Kerguelen.

We found this bird (the Goney of the whalers) nesting at Marion Island, Possession Island, and Kerguelen; and during our cruises in the Southern and Antarctic Oceans, it was an almost constant follower of the ship, except to the south of Heard Island, and in the immediate neighbourhood of the Antarctic ice. Its habitat seems especially to be the westerly winds of the Southern Ocean. The nests were at Kerguelen generally scattered about on the mossy slopes of the headlands, and were often three hundred feet above the sea.

The nests are about one foot high, and two feet in diameter, and are built of earth, grass, *Azorella*, and decayed vegetable matter. The nests are widely separated from each other, that is to say, that I never saw two nests nearer to each than fifty yards. We found one egg in each nest; I saw no young during our visit (January).

The whalers told us that they were very fond of the young Goneys, and ate great numbers of them; they were the best eating of any of the birds.

They seem to have considerable difficulty in rising on the wing, from the places where they build their nests. I noticed several run for over two hundred yards with extended wings before they got fairly off. On many of our specimens there was a beautiful rose tinge on each side of the head.

The heaviest specimen we weighed was 19 lbs., and measured 11–6 from tip to tip of the wings.]

Eggs of this Albatross from Kerguelen and Marion Island are in the collection. Mr Moseley (Naturalist, p. 134) states that at Tristan da Cunha, this Albatross breeds "actually within the crater of the terminal cone 7000 feet or more above the sea." See also Mr Moseley's description of the breeding of this species on Marion Island (*l.c.*, p. 172).

20. *Diomedea brachyura*, Temm.

*Diomedea brachyura*, Temm., Pl. Col., p. 554; Coues, Pr. Ac. Phil., 1866, p. 177; Salv., Proc. Zool. Soc., 1878, p. 740.

[Nos. 517–519. Males.
No. 520. Female. } North Pacific.

These were all caught with the hook from the ship while at sea in June and the first half of July 1874, between Japan and Honolulu; they followed the ship every day in numbers till we got into the trade-winds, when no more were observed.

No. 509. Female. North Pacific.

Eyes brown; bill black. Stomach empty. Shot on April 1, 1875, by Lord Campbell, with the Henry rifle, while on the wing. We were just north of the tropic; but this bird, as well as another Albatross, were seen some days before we had passed out of the tropics.

No. 511. Male. North Pacific.

Eyes brown; feet and bill dark or nearly black. Stomach had cuttlefish. Caught with a hook by Pearcey on April 7, 1875.

We first met this bird at sea in lat. 19° 25′ N., in April 1875. It was after that a constant attendant on the ship, during the whole of our cruise in the North Pacific, till we reached 26° 11′ N. of the Sandwich Islands.

It was occasionally in great numbers, and was frequently and easily taken with the hook at the stern of the ship.]

21. *Diomedea melanophrys*, Temm.

*Diomedea melanophrys*, Temm., Pl. Col., p. 456; Coues, Pr. Ac. Phil., 1866, p. 181; Sharpe, Zool. Kerg., Birds, p. 46; Salv., Proc. Zool. Soc., 1878, p. 740.

[Male. } Shot at sea, July 8, 1874.
Female. }

Male.
Female. Christmas Harbour, Kerguelen.

This bird as well as *Diomedea chlororhyncha* is called the 'Molly Mauk' by the sailors and sealers. It was a frequent attendant on the ship, especially in the region of the southerly winds.

We did not notice it south of Heard Island. We never saw any nests of this bird.]

22. *Diomedea fuliginosa*, Gm.

*Diomedea fuliginosa*, Gm., Syst. Nat., vol. i. p. 595; Sharpe, Zool. Kerg., Birds, p. 48; Salv., Proc. Zool. Soc., 1878, p. 740.

*Phœbetria fuliginosa*, Coues, Pr. Ac. Phil., 1866, p. 186; Coues and Kidder, Bull. Nat. Mus., No. 2, p. 21.

[Male. Ice Barrier, February 16, 1874.

Female. Royal Sound, Kerguelen, January 17.

We met with this bird, the 'Piv' or 'Piew' of the sealers, all over the Southern and Antarctic Oceans, down to and even among the Antarctic icebergs. Von Suhm is said to have found three nests on high land near Christmas Harbour. I never met with any nests of this bird.]

23. *Diomedea chlororhyncha*, Gm.

*Diomedea chlororhynchos*, Gould, B. Austr., vii. t. 42.

No skins were preserved of this Albatross, but examples were brought home in spirits. Mr Murray sends the subjoined note respecting it :—

"We found these birds building their nests and sitting on their eggs at Nightingale Island.

"The nests were raised about eleven inches above the ground, and about one and a half feet in diameter, were composed of grass, sticks, and earth. Many of them were situated in the Penguin rookeries, under the tall tussock-grass; but the great majority were in the more open ground, under the clumps of *Phylica*.

"We noticed these birds walking to some projecting piece of rock, from which they took flight. This species appears to me much more limited in its distribution than *Diomedea melanophrys*. It was seldom noticed about the ship, except near the Tristan group."

Mr Moseley (Notes, p. 129) says of this species at Nightingale Island :—

"Amongst the Penguins here were numerous nests of the yellow-billed Albatross (*Diomedea culminata*), called by the Tristan people 'Mollymauk,' variously spelt in books, Molly Hawk, Mollymoy, Mollymoc, Mallymoke. It is, as are most of the sealers' names in the south, a name originally given to one of the Arctic birds, the Fulmar, and then transferred to the Antarctic from some supposed or real resemblance."

# APPENDIX.

## I.—LIST OF BIRDS' EGGS OBTAINED DURING THE CHALLENGER EXPEDITION.

| | LOCALITY. | NO. OF EGGS. |
|---|---|---|
| *a.* PASSERES. | | |
| 1. *Phrygilus melanoderus*, Q. et. G. (?), | Falklands, | 2 |
| 2. *Turdus falklandicus*, Q. et G. (?), | ,, | 2 |
| 3. *Anthus correndera*, Vieille, | ,, | 2 |
| *b.* ACCIPITRES. | | |
| 4. *Milvago australis*, Gm. (?), | Falklands, | 2 |
| 5. *Buteo erythronotus*, King (?), | ,, | 2 |
| 6. *Cathartes aura*, Linn., | ,, | 2 |
| *c.* STEGANOPODES. | | |
| 7. *Phalacrocorax verrucosus*, Cab., | Kerguelen, | 10 |
| 8. *Phalacrocorax albiventris*, Less., | Falklands, | 2 |
| 9. *Sula leucogastra*, Bodd., | Raine Island, | 1 |
| 10. *Sula cyanops*, Sund., | ,, | 1 |
| 11. *Sula piscator*, Linn., | ,, | 1 |
| *Sula*, sp. inc., | ,, | 9 |
| 12. *Phaeton æthereus*, Linn., | Bermuda, | 4 |
| 13. *Fregata aquila*, Linn., | Ascension, | 5 |
| *d.* HERODIONES. | | |
| 14. *Nycticorax obscurus*, Bp., | Falklands, | 2 |
| *e.* ANSERES. | | |
| 15. *Bernicla magellanica*, Gm., | Falklands, | 2 |
| 16. *Bernicla antarctica*, Gm., | ,, | 2 |
| 17. *Tachyeres cinereus*, Gm., | ,, | 2 |
| ,, ,, | Elizabeth Island, | 1 |
| 18. *Querquedula eatoni*, Sharpe, | Kerguelen, | 7 |
| 19. *Querquedula flavirostris*, Vieil., | Falklands, | 2 |
| 20. *Anas cristata*, Gm., | ,, | 2 |

| | LOCALITY. | NO. OF EGGS. |
|---|---|---|
| *f.* COLUMBÆ. | | |
| 21. *Carpophaga rhodinolæma*, Scl., | Admiralty Islands, | 3 |
| *g.* GALLINÆ. | | |
| 22. *Numida meleagris*, Linn., | Ascension, | 2 |
| *h.* LIMICOLÆ. | | |
| 23. *Chionis minor*, Hartl., | Kerguelen, | 8 |
| 24. *Hæmatopus*, sp. inc., | Falklands, | 2 |
| 25. *Gallinago frenata*, Max. (?), | ,, | 2 |
| 26. *Eudromias modesta*, Licht., | ,, | 2 |
| *i.* GAVIÆ. | | |
| 27. *Sterna fuliginosa*, Gm., | Raine Island, | 15 |
| ,, ,, | Ascension, | 7 |
| 28. *Sterna hirundinacea*, Less., | Elizabeth Island, | 16 |
| 29. *Sterna*, sp. inc., | Heard Island, | 1 |
| 30. *Anous stolidus*, Linn., | Raine Island, | 9 |
| 31. *Larus dominicanus*, Licht., | Kerguelen, | 1 |
| ,, ,, | Elizabeth Island, | 2 |
| ,, ,, | Falklands, | 2 |
| 32. *Larus*, sp. inc., | ,, | 2 |
| 33. *Stercorarius antarcticus*, Less., | Nightingale Island, | 4 |
| ,, ,, | Falklands, | 2 |
| *j.* TUBINARES. | | |
| 34. *Diomedea exulans*, Linn., | Kerguelen, | 1 |
| ,, ,, | Marion Island, | 3 |
| 35. *Diomedea*, sp. inc., | Nightingale Island, | 1 |
| 36. ,, | Tristan da Cunha, | 3 |
| 37. *Diomedea melanophrys*, Temm., | Falklands, | 3 |
| 38. *Majaqueus æquinoctialis*, Linn., | Kerguelen, | 2 |
| 39. *Œstrelata lessoni*, Garn. (?), | ,, | 10 |
| 40. *Daption capensis*, Linn. (?), | ,, | 1 |
| 41. *Prion desolatus*, Gm., | ,, | 21 |
| 42. *Pelecanoides garnoti*, Less., | ,, | 1 |
| ,, ,, | Falklands, | 2 |
| 43. *Fregetta melanogastra*, Gould (?), | Kerguelen, | 1 |
| ,, ,, | Falklands, | 1 |
| *k.* IMPENNES. | | |
| 44. *Aptenodytes longirostris*, Scop., | Marion Island, | 1 |
| 45. *Aptenodytes*, sp. inc. (?), | Heard Island, | 5 |

| | LOCALITY. | NO. OF EGGS. |
|---|---|---|
| 46. *Eudyptes chrysolophus*, Brandt, | Falklands, | 2 |
| ,, ,, | Kerguelen, | 4 |
| 47. *Eudyptes chrysocome*, Forst., | Falklands, | 2 |
| ,, ,, | Inaccessible Island, | 6 |
| 48. *Pygosceles tæniatus*, Peale, | Falklands, | 7 |
| 49. *Spheniscus magellanicus*, Forst., | ,, | 2 |
| *l.* CRYPTURI. | | |
| 50. *Calodromas elegans*, D'Orb et Geoffr., | Falklands, | 2 |

The eggs of the Falkland Islands were nearly all presented to the Expedition by Mr Deans, of Stanley, Falkland Islands

## II.—NOTE ON THE GIZZARD AND OTHER ORGANS OF *CARPOPHAGA LATRANS*.

By A. H. GARROD, M.A., F.R.S., Prosector to the Zoological Society of London.

(Reprinted from the Proceedings of the Zoological Society for 1878.)

In the collection of birds preserved in spirit by H.M.S. Challenger is the body, after the skin had been removed, of a single specimen of *Carpophaga latrans*, together with the gizzard of a second individual of the same species, obtained at Kandavu, Fiji. These form the material for the present communication.

In his note-book Mr John Murray makes the following remarks on the species:[1]—"Stomach contained the fruit of some tree unknown to me. The coat of the stomach had hard papilla-like ossifications of a circular form, two or three rows. . . . These indurations are composed of a horny substance,"—from which it is seen that Mr Murray was the first to recognise the existence of the strange arrangement to be here described.

The thin-walled and capacious crop contained only one thing in its interior—a complete fruit, which has been identified for me by Mr W. T. Thiselton Dyer, as that of *Oncocarpus vitiensis*. In the gizzard was also found a portion of a second example of the same fruit.

*Oncocarpus vitiensis* is a tree belonging to the natural order Anacardiaceæ, which, according to Dr Seemann,[2] is "about 60 feet high, bearing large oblong leaves and a very curious corky fruit, somewhat resembling the seed of a walnut." The tree is included among those which are poisonous by the Fijians; and its sap produces an intense itching of the skin when brought into contact with it, whence the native name Kau Karo, or itch-wood.

For the crushing of this very hard fruit a special anatomical modification of the gizzard-walls of this Fruit-pigeon is developed, which is peculiarly interesting and tends to prove the plasticity of organs when aberrant forces come into play.

The gizzard is not developed to anything like the extent that it is in the Gallinæ or Anseres,

[1] *Vide* Proc. Zool. Soc., 1877, p. 737.

[2] Seemann's Mission to Viti, p. 334.

but, as in most Carpophagine birds, is small, and has its muscular walls comparatively ill-developed. No stones of any kind were found in it.

It is the epithelial lining which is so peculiar in *Carpophaga latrans*. Instead of being smooth, or folded into plications, as is usually the case, its surface is raised into horny cones which closely resemble in appearance the tubercles for the attachment of the spines of the Echinoderm genus *Cidaris*. In fig. 1, *a*, the interior of the gizzard is represented; fig. 1, *b*, is a section of one of the cones resting upon the muscular gizzard-wall.

These conical processes are corneous throughout, are erect, and are quite transparent when cut into sections. There are twenty-three of them, large and small, in each of my specimens. The larger ones, which are the more numerous, average seven millimetres in diameter at their bases, their axial length being about four millimetres; the smallest cone is four millimetres across and of nearly the same height.

The cones are arranged, close to one another, in a fairly regular manner upon the muscle-masses, being distributed in rows of three, counting either transversely or longitudinally. This disposes of eighteen of the twenty-three cones. The remaining five are found on the tendinous intermuscular walls of the organ, in longitudinal rows, two in one row, three in the other.

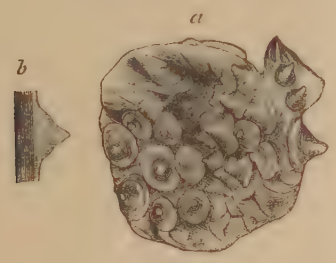


Fig. 1.
Interior of the Gizzard of *Carpophaga latrans*.

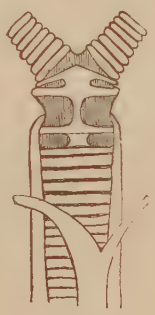

Fig. 2.
Syrinx of *Carpophaga latrans*.

A section of any one of the cones demonstrates that it is not in the least ossified, but corneous throughout, and of about the density of ox-horn. It is also seen that the attached surface of the epithelium does not participate in the undulations of the free surface, being quite smooth. Neither does it send any processes into the cones. Between the cones the epithelium is yielding, and only semicorneous.

A still further exaggeration of this abnormal condition of the epithelium of the gizzard of *Carpophaga latrans* has been described by MM. Jules Verreaux, and O. Des Murs in *Phœnorhina goliath*[1] of New Caledonia, which "se nourrit de graines de *semicarpum*." In this bird "le gosier, déjà on ne peut plus musculeux par lui-même, a sa surface intérieure régulièrement recouverte . . . de pointes véritablement osseuses, rappelant la forme de celles qui se voient à la surface du corps de la *Raia* bouclée, ou *Clavel*, ou *Clavelade*. Ces pointes, en cône aplati, ont leur base plane de 5 millim. de diamètre, d'une hauteur de 5 à 6 mill., sont légèrement inclinées sur ellesmêmes, et quelquefois recourbées par la dessication, l'extrémité en étant mousse." A central fibrous peduncle is also said to run through each osseous element.

[1] Revue et Magasin de Zoologie, 1862, p. 168.

*Phænorhina goliath*, from what has been said above, therefore differs from *Carpophaga latrans* in having the cones of the gizzard proportionally longer, at the same time that they are ossified (which necessitates the presence of vessels in the ossification, which appear after death as the fibrous cord) and oblique. There is, however, a great similarity between the two organs.

I am informed by the Rev. S. J. Whitmee that *Carpophaga pacifica* in the Samoan Islands feeds on nutmegs, from which it is highly probable that in that species the gizzard-epithelium is modified in a manner similar to that of the Fiji or New Caledonian species. Specimens of *Carpophaga pacifica* preserved would therefore be of special interest for the determination of this point.

With reference to the other parts of *Carpophaga latrans*, the intestine is very capacious, only nine inches long, and transversely sacculated from the contraction of its outer longitudinal muscular coat, this producing the appearance of thirty bold transverse folds on the mucous surface. There are no colic cæca; and, as in the genus *Carpophaga* generally,[1] the gall bladder is well developed. The liver-lobes are equal in size.

The syrinx (fig. 2, p. 153) is Columbine, with its lateral muscles attached inferiorly to the membrane between the penultimate and antepenultimate tracheal rings. The trachea is composed of rings which are very yielding in the middle line posteriorly. As can be seen in the figure, the musculi sterno-tracheales, which are independent of the intrinsic muscles, are not quite symmetrically attached.

The furcula, as is the rule in the subfamily, is very slender, but complete, wherein this species differs from *Phænorhina goliath*, in which it is cartilaginous at its symphisial end, according to MM. Verreaux and Des Murs.[2]

Myologically, the ambiens is to be found, not large; the femoro-caudal with its accessory head are well developed; the semitendinosus and its accessorius are the same.

There are two carotids; so that in this as well as all the other features above mentioned *Carpophaga latrans* agrees with my definition of the division of the Columbidæ into which it naturally falls, its gizzard differing, however, from that of all but one of the species which have been examined.

[1] *Vide* Proc. Zool. Soc. 1874, p. 258.

[2] *Loc. cit.*, p 140.

# EXPLANATION OF THE PLATES.

## PLATE I.

*Loriculus panayensis* (p. 9), ♂ and ♀, from specimens 348, 349

## PLATE II.

*Batrachostomus septimus* (p. 13), from specimen 427.

## PLATE III.

*Buceros mindanensis* (p. 15), from specimen 407.

## PLATE IV.

*Dicrurus striatus* (p. 17), from specimen 420.

## PLATE V.

Fig. 1. *Dicæum mindanense* (p. 20), from specimen 433.
Figs. 2, 3. *Nectarophila juliæ* (p. 20), from specimens 403, 404.

## PLATE VI.

*Phabotreron brevirostris* (p. 22), from specimen 426.

## PLATE VII.

Fig. 1. *Monarcha infelix* (p. 27), from specimen 497.
Fig. 2. *Rhipidura semirubra* (p. 27), from specimen 496.
Fig. 3. *Myzomela pammelæna* (p. 28), from specimen 491.

## PLATE VIII.

*Philemon albitorques* (p. 28), from specimen 481.

## PLATE IX.

*Carpophaga rhodinolæma* (p. 31), from specimen 471.

## PLATE X.

*Ptilopus johannis*, ♂ and ♀ (p. 32), from specimens 461, 462.

## PLATE XI.

*Megapodius eremita* (p. 32), from specimen 472.

## PLATE XII.

Fig. 1. *Ptilotis carunculata* (p. 45), from specimen 47.
Fig. 2. *Ptilotis procerior* (p. 46), from specimen 74.

## PLATE XIII.

*Ptilotis provocator*, ad. et. jr. (p. 47), from specimens 65, 84.

## PLATE XIV.

Fig. 1. *Zosterops flaviceps* (p. 48), from specimen 71.
Fig. 2. *Zosterops explorator* (p. 48), from specimen 57.

## PLATE XV.

*Chrysœnas victor*, ♂ (p. 51), from the single specimen obtained.

## PLATE XVI.

*Chrysœnas viridis*, ♂ (p. 51), from specimen 81.

## PLATE XVII.

*Carpophaga latrans* (p. 52), from specimen 88.

## PLATE XVIII.

Fig. 1. *Pachycephala phæonota* (p. 65), from specimen 291.
Fig. 2. *Rhipidura squamata* (p. 65), from specimen 289.

## PLATE XIX.

*Graucalus pollens* (p. 68), from specimen 280.

## PLATE XX.

*Trichoglossus nigrigularis* (p. 75), from specimen 237.

## PLATE XXI.

*Buteo solitarius* (p. 96), from specimen 540.

## PLATE XXII.

*Anas wyvilliana* (p. 98), from specimen 541.

## PLATE XXIII.

*Nesocichla eremita* (p. 111), from specimen *f*.

## PLATE XXIV

*Nesospiza acunhæ* (p. 112), from specimen *d*.

## PLATE XXV.

Fig. 1. *Phalacrocorax imperialis* (p. 120), from specimen 637.
Fig. 2. Head of *Phalacrocorax albiventris* (p. 121), from an example in the Collection of Messrs Salvin & Godman.

## PLATE XXVI.

*Phalacrocorax verrucosus* (p. 122). Fig. 1, adult, from specimen *a*; fig. 2, young, from specimen *d*.

## PLATE XXVII.

*Spheniscus demersus* (p. 124), from specimen *a*.

## PLATE XXVIII.

*Spheniscus magellanicus* (p. 125). Fig. 1, adult; fig. 2, young,—from specimens 689 and 741.

## PLATE XXIX.

*Eudyptes chrysolophus* (p. 127). Fig. 1, adult, from specimen *c*; fig. 2, pale variety, from specimen *e*.

## PLATE XXX.

*Eudyptes chrysocome* (p. 128). Fig. 1, adult, from specimen *e*; fig. 2, young, from specimen 727.

# INDEX.


*Accipiter etorques*, Scl., 74.
*poliocephalus*, G. R. Gr., 74.
*Actitis incana*, Gm., 33.
*Adamastor cinereus*, Gm., 143.
*Ægialitis geoffroyi*, Wagl., 64.
*inornatus*, Gould, 84, 92.
*Ægotheles wallacii*, G. R. Gr., 77.
*Æluræedus arfakianus*, Meyer, 82.
*melanotis*, G. R. Gr., 82.
*Alcedo bengalensis*, Gm., 114.
*chloris*, Bodd., 13.
*diops*, Temm., 60.
*gularis*, Kuhl., 13.
*Anœretes fernandezianus*, Philippi, 101.
*parulus*, Kittl., 101.
*Anas boschas*, Dole, 98.
*obscura*, 98.
*pelewensis*, H. & F., 52, 53, 55.
*superciliosa*, Gm., 52, 53, 98.
*wyvilliana*, Scl., 98, 157.
*Anous melanogenys*, Gray, 34, 113, 137.
*stolidus*, Linn., 33, 113, 137.
*tenuirostris*, 137.
*Aptenodytes*, sp., 151.
*chrysocome*, Forst, 127, 128.
*longirostris*, Scop., 122, 123, 132, 151.
*magellanicus*, Forst, 125.
*papua*, Forst, 124.
*tæniata*, Peale, 124.
*Aplonis marginata*, Gould, 37.
*tabuensis*, Gm., 37, 50.
*vitiensis*, Layard, 50.
*Arachnechthra jugularis*, Linn., 6, 8, 21.
*Ardea javanica*, Horsf., 64.
*sacra*, Gm., 24, 31, 39, 52, 58.
*Arses insularis*, Meyer, 116.
*Artamus leucopygialis*, Gould, 85.
*leucorhynchus*, Linn., 6, 16.
*melaleucus*, Forst, 55.
*Artamides pollens*, Salvad., 68.
*Asio accipitrinus*, Sharpe, 96.
*brachyotus*, Forst., 96, 104.
*galapagoensis*, Cass., 96.
*Astur æquatorialis*, Wall., 41.
*contumax*, Rosenb., 74.
*cruentus*, Schleg., 40, 41.
*griseigularis*, 40, 41.
*henicogrammus*, Gray, 41.
*hiogaster*, S. Müll., 61.
*poliocephalus*, G. R. Gr., 74.
*rufitoriques*, Peale, 40.
*tabuensis*, 42.
*Attagen ariel*, Gould, 117.

*Batrachostomus septimus*, Tweedd., 7, 8, 13, 155.
Bee-eater, Yellow-tufted, 94.
*Bernicla antarctica*, Gm., 106.
*poliocephala*, Scl., 107.
*Botaurus pœciloptilus*, 115.
*Broderipus acrorhynchus*, Vigors, 6, 7, 8, 18.
*Buceros hydrocorax*, 15, 16.
*mindanensis*, Tweedd., 7, 8, 15, 16, 155.
*Budytes viridis*, Gm., 63.
*Buteo desertorum*, 97.
*japonicus*, Bp., 116.
*solitarius*, Peale, 93, 96, 98, 157.
*vulgaris*, 97.
*Butorides javanica*, Horsf., 64.

*Cacomantis castaneiventris*, 43.
*flabelliformis*, Lath., 90.
*Calobates melanope*, Pallas, 7, 8, 19.
*Calornis amboinensis*, Gray, 29, 70.
*gularis*, G. R. Gr., 29, 70, 71.
*metallica*, Temm., 29, 70, 81.
*nitida*, G. R. Gr., 70.
*panayensis*, Scop., 6, 8, 22.
*purpurascens*, G. R. Gr., 70.

*Calornis purpureiceps*, Salvad., 29.
*viridescens*, G. R. Gr., 29, 70.
*Campephaga maculosa*, Peale, 36.
*melanops*, Lath., 78.
*Campephilus magellanicus*, Gm., 103.
*Caprimulgus brachyurus*, Rosenb., 77.
*Carbo albiventer*, Less., 121.
*Carpophaga ænea*, 31.
*assimilis*, Gould, 91.
*chalybea*, Bp., 66.
*chalybura*, G. R. Gr., 66.
*concinna*, Wall., 66, 71.
*latrans*, Peale, 51, 52, 152, 153, 154, 157.
*oceanica*, Less., 38.
*pacifica*, Gm., 38, 55, 154.
*rhodinolæma*, Scl., 31, 156.
*roseinucha*, Schl., 66.
*zoëæ*, Less., 83.
*Casuarius galeatus*, Lath., 64.
*Catarractes chrysolophus*, Brandt, 127, 128.
*Cathartes aura*, Linn., 105.
*Ceblepyris karu*, Less., 69.
*plumbea*, S. Mull., 78, 79.
*rufiventris*, Jacq. & Pucher, 69.
*Centrites niger*, Bodd., 101.
*Centrococcyx viridis*, Scop., 6, 15.
*Centropus phasianus*, Lath., 90.
*Certhia carunculata*, Gm., 36, 45.
*jugularis*, Linn., 21.
*sanguinea*, Gm., 95.
*Ceryle stellata*, Meyen, 104.
*Ceyx lepida*, Temm., 62.
*Chalcopsitta rubrifrons*, G. R. Gr., 75.
*Chalcopsittacus scintillatus*, Temm., 75.
*Charadrius fulvus*, Gm., 6, 8, 23, 63.
*geoffroyi*, Wagl., 64.
*mongolicus*, Pallas, 33.
*veredus*, Gould, 64.
*Chasiempis sandvicensis*, Gm., 94.
*Chibia assimilis*, G. R. Gr., 79.
*hottentotta*, Linn., 69.
*megalornis*, G. R. Gr., 69.
*Chionis minor*, 113.
*Chrysocolaptes hæmatribon*, 10, 11.
*lucidus*, Scop., 7, 10, 11.
*maculiceps*, Sharpe, 10, 11.
*stricklandi*, 11.
*xanthocephalus*, 11.
*Chrysœna luteovirens*, 51.
*Chrysœnas viridis*, Layard, 51, 157.
*Chrysœnas victor*, Gould, 51, 156.
*Cicinnurus regius*, Linn., 81.
*Cinclodes patachonicus*, Gm., 102.
*Cinnyris aspasioides*, G. R. Gr., 63.
*auriceps*, G. R. Gr., 61.
*clementiæ*, Less., 62.
*frenatus*, S. Müll., 61.
*Cnipolegus*, sp., Scl., 94.
*Collocalia cinerea*, Finsch, 55.
*francica*, Gm., 56.
*fuciphaga*, Thunb., 55, 56.
*leucopygia*, Wall., 54.
*linchi*, Verr. et Des Murs., 54.
*spodiopygia*, Peale, 34, 44.
*uropygialis*, G. R. Gr., 53.
*vanicorensis*, 35, 56.
*Colluricincla maculosa*, Peale, 36.
*megarhyncha*, Q. and G., 79.
*parvissima*, 86.
*rufigaster*, Gould, 86.
*Columba bicolor*, Scop., 23.
*castaneiceps*, Peale, 52.
*œnas*, Linn., 108.
*vitiensis*, Q. and G., 51.
*zoëæ*, Less., 83.
*Conurus smaragdinus*, Gm., 104.
*Coracias orientalis*, Linn., 12.
*Corvus brevipennis*, Schl., 21.
*enca*, 22.
*philippinus*, Bp., 6, 8, 21, 22.
*validissimus*, 22.
*validus*, 21, 22.
*violaceus*, 22.
*Corydalla lugubris*, Walden, 6, 8, 19.
*Coturnix communis*, Bonn., 114.
*Cracticus cassicus*, Bodd., 80.
*Craspedophora magnifica*, Gould, 87.
*Crithagra insularis*, Cab., 112.
*Cuculus bronzinus*, Gray, 43.
*cineraceus*, Gould, 90.
*flabelliformis*, Lath., 43.
*infuscatus*, 43.
*mindanensis*, Linn., 14.
*simus*, Peale, 43.
*viridis*, Scop., 15.
*Cuncuma leucogaster*, Gm., 73.
*Curœus aterrimus*, Kittl., 101.
*Cyanalcyon diops*, Temm., 60.
*macleayi*, Jard. & Selby, 85.

*Cyclopsittacus melanogenys*, Rosenb., 74.
*Cypselus mystaceus*, Less., 62.
*Cyrtostomus frenatus*, S. Müll., 61, 80.
*melanogaster*, G. R. Gr., 62.
*zenobia*, Less., 62.

*Dacelo gaudichaudi*, Q. and G., 77.
*grayi*, Schleg., 54.
*tyro*, G. R. Gr., 77.
*Daption capensis*, Linn., 144, 151.
*Demiegretta sacra*, Gm., 6, 8, 24.
*Dermophrys jagori*, Cab., 22.
*Dicæum hirundinaceum*, Shaw, 89.
*mindanense*, Tweedd., 7, 8, 20, 155.
*vulneratum*, Wall., 63.
*Dicruropsis assimilis*, G. R. Gr., 79.
*megalornis*, G. R. Gr. 69.
*Dicrurus assimilis*, G. R. Gr., 79.
*balicassius*, 17.
*megalornis*, G. R. Gr., 69.
*pectoralis*, Wall., 70.
*striatus*, Tweedd., 7, 8, 17, 155.
*Diomedea brachyura*, Temm., 147.
*chlororhyncha*, Gm., 148, 149.
*culminata*, 149.
*demersa*, Linn., 124.
*exulans*, Linn., 147, 151.
*fuliginosa*, Gm., 148.
*melanophrys*, Temm., 148, 149, 151.
sp., 151.
*Domicella atricapilla*, Wagl., 60.
*cyanauchen*, Müll., 60.
*rubra*, Gm., 68.
*schlegeli*, Finsch, 68.
*scintillata*, Temm., 75.
*solitaria*, Gm., 42.
*Drepanis coccinea*, Merr., 95.
*flava*, Bloxham, 95.
*sanguinea*, Gm., 95.
*Drymaœdus beccari*, Salvad., 73, 80.
*Drymophila cinerascens*, Temm., 65.
*Dysporus cyanops*, Sund., 120.
*piscator*, F. and H., 120.

*Eclectus grandis*, Gm., 59.
*linnæi*, Wagl., 75.
*megalorhynchus*, Bodd., 59.
*personatus*, Schl., 67.
*polychlorus*, Scop., 59, 75.
*polychlorus*, var. *aruensis*, G. R. Gr., 75.
*Eclectus rhodops*, G. R. Gr., 61,
*roratus*, Müll., 59
*Edoliosoma schisticeps*, G. R. Gr., 79.
*tenuirostre*, Jard. & Selby, 78.
*muelleri*, Salvad., 78.
*Elainea albiceps*, D'Orb. et Lafr., 102.
*Emberiza brasiliensis*, Carm., 112.
*Entomobia gularis*, Kuhl, 6, 7, 8, 13.
*Eos cyanogenys*, 68.
*indica*, 115.
*riciniata*, 68.
*rubra*, Gm., 68.
*Erythrauchæna humeralis*, Temm., 91.
*Erythropitta erythrogastra*, Temm., 7, 18.
*Esacus magnirostris*, Temm., 33,
*Eudromias modesta*, Licht., 109.
*veredus*, Gould, 64.
*Eudynamis mindanensis*, Linn., 7, 8, 14.
*Eudyptes chrysocome*, Forst, 113, 127, 128, 129, 132, 152, 158.
*chrysolophus*, Brandt, 127, 132, 152, 158.
*diadematus*, Gould, 127.
*nigriventris*, Gould, 128.
*pachyrhynchus*, Gray, 129.
*saltator*, Sharpe, 127, 128.
*Eurystomus orientalis*, Linn., 7, 12.
*Eustephanus fernandensis*, King, 103.
*galeritus*, Mol., 103.

*Falco hiogaster*, S. Müll., 61.
Flycatcher, dusky, 94.
sandwich, 94.
*Fregata aquila*, Linn., 117, 118.
*ariel*, Gould, 30.
*minor*, Gm., 117, 118.
*Fregetta gracilis*, 141.
*grallaria*, Vieill., 141, 142.
*melanogastra*, Gould, 142.
*Fulica alai*, Peale, 99.

*Gallinago paraguaiæ*, Vieill., 109.
*stenura*, Kuhl, 7, 8, 24, 64.
*Gallinula nesiotis*, Scl., 113.
*Gambetta pulverulentus*, Müll., 92.
*Geoffroyus aruensis*, G. R. Gr., 62.
*keyensis*, Schl., 67.
*pucherani*, Bp., 62.
*rhodops*, G. R. Gr., 61.
*schlegeli*, Salvad., 61.
*Geopelia humeralis*, Temm., 91.

*Geopelia tranquilla*, Gould, 91.
*Geranoaëtus melanoleucus*, Vieill., 104.
*Gracula nobilis*, Merr., 94.
*Graucalus caledonicus*, Gm., 68.
*hypoleucus*, Gould, 86.
*melanops*, Lath., 78.
*personatus*, Müll., 69.
*pollens*, Salvad., 68, 157.
*temmincki*, 69.
Grosbeak, Parrot-billed, 94.
*Gygis candida*, Gm, 136.
*microrhyncha*, 136.

*Hæmatopus*, sp., 150.
*ater*, Vieill., 109.
*leucopus*, Garnot, 108,
*unicolor*, 115.
*Halcyon albicilla*, Gray, 30.
*cassini*, F. and H., 44.
*diops*, Temm., 60.
*juliæ*, Heine, 54.
*macleayi*, Jard. and Selby, 85.
*pealí*, F. and H., 44.
*pileata*, Bodd., 114.
*sacra*, F. and H., 54.
*sacra*, Gm., 35, 44.
*sancta*, Vig. & Horsf., 76.
*saurophaga*, Gould, 30.
*sordida*, G. R. Gr., 76.
*veneratus*, Gm., 56, 57.
*Haliaëtus girrenera*, Vieill., 73.
*leucogaster*, Gm., 30, 73.
*Haliastur girrenera*, Vieill., 73.
*intermedius*, Blyth, 6, 7, 8, 10.
*Halieus verrucosus*, Cab., 122.
(*Hypoleucus*) *verrucosus*, Cab., 122.
*Harpactes ardens*, Temm., 7, 11.
*Hemipodius melanotus*, Gould, 91.
*Hermotimia aspasioides*, G. R. Gr., 63.
*auriceps*, G. R. Gr., 61.
*Hiaticula inornata*, Gould, 92.
*Hirundo domicola*, Jerd., 44.
*frontalis*, Q. and G., 78.
*gutturalis*, Scop., 18, 116.
*javanica*, Sparrm., 44, 78.
*meyeni*, Cab., 100.
*nigricans*, Vieill., 78.
*rustica*, 116.
*subfusca*, Gould, 43.
*tahitica*, Gm., 43, 53.

*Hydrochelidon hybrida*, Pallas, 6, 25, 133.
*nigricans*, Vieill., 78.
*Hypothymis azurea*, Bodd., 7, 8, 17.
*Hypsipetes philippinensis*, Gm., 6, 19.
*rufigularis*, Sharpe, 7, 8, 19.

*Ixus goiavier*, Scop., 6, 7, 8, 18.

*Lalage dominica*, P. L. S. Müller, 6, 17.
*karu*, Less., 69.
*leucomelæna*, Sharpe, 69.
*maculosa*, Peale, 36, 37, 50.
*polygrammica*, G, R. Gr., 69.
*terat*, Cass., 36, 37.
*Lamprotornis metallicus*, Temm., 70.
*Lamprotreron superbus*, Temm., 90.
*Lanius cucullatus*, Licht., 60.
*karu*, Less., 69.
*leucorhynchus*, Linn., 16.
*lucionensis*, Linn., 6, 16.
*Larus*, sp., 151.
*canus*, Linn., 138.
*dominicanus*, Licht., 139, 151.
*glaucodes*, Meyen, 138.
*hartlaubi*, Bruch., 139.
*jamesoni*, Wils., 139.
*maridus*, 139.
*novæ-hollandiæ*, Steph., 139.
*ridibundus*, Linn., 6, 25, 138.
*scopulinus*, 139.
*Lestris antarcticus*, Less., 139, 140.
*pomarinus*, Temm., 140.
*Loriculus chrysonotus*, 10.
*panayensis*, Tweedd., 6, 8, 9, 155.
*regulus*, Souancé, 9, 10.
*Lorius cyanauchen*, Müll., 59, 60.
*domicella*, Linn., 59, 60.
*solitarius*, Gm., 42.
*Loxia melaleuca*, Forst., 55.
*psittacea*, Gm., 94.
*Loxioïdes bailleui*, 93.

*Machœrorhyncus xanthogenys*, G. R. Gr., 78.
*Macropteryx mystacea*, Less., 62, 77.
*Macropygia amboinensis*, Linn., 63, 72.
*doreya*, Bp., 72, 83.
*keyensis*, Salvad., 71.
*phasianella*, G. R. Gr., 71, 83.
*turtur*, Schleg., 71.
*Manucodia atra*, Less., 82.

*Manucodia gouldi*, Gray, 86.
*keraudreni*, Gould, 86, 87.
*Majaqueus æquinoctialis*, Coues & Kidder, 143, 144, 151.
*Mareca sibilatrix*, Poepp., 107.
*Megaloprepia assimilis*, Gould, 91.
Megapode reinwardt, Temm., 83.
*Megapodius duperreyi*, Less. & Garn., 83.
*eremita*, Hartl., 32, 156.
*hueskeri*, Cab. et Reichen., 32.
*reinwardtii*, Temm., 83.
*rubrifrons*, Scl., 32.
*rubripes*, Temm., 83.
*rufipes*, S. Müll., 83.
*tumulus*, Gould, 91.
*Mellisuga coccinea*, Merr., 95.
*Merops bicolor*, Bodd., 7, 11.
*niger*, Gm., 94.
*ornatus*, Lath., 84, 85.
*philippinus*, Linn., 1, 6, 7, 8, 11.
*Microglossus alecto*, Temm., 74.
*aterrimus*, Gm., 74, 90.
*Micropterus cinereus*, Gm., 107.
*Milvago chimachima*, 96.
*chimango*, Vieill., 105.
*Mimeta flavocinctus*, King, 88.
*viridis*, Lath., 87.
*Miño dumonti*, Less., 81.
*Miro albifrons*, 115.
*Mohoa nobilis*, Merr., 94.
*Monarcha fulviventris*, Hartl., 27, 65.
*infelix*, Scl., 27, 156.
*inornatus*, Garnot, 27, 65.
*insularis*, Meyer, 116.
*lessoni*, Q. and G., 49.
*loricata*, Wallace, 27, 28.
*Motacilla melanope*, Pallas, 19.
*Munia jagori*, Cab., 6, 8, 22.
*malabarica*, 95.
*nisoria*, Temm., 95.
*punctularia*, 95.
*Muscicapa azurea*, Bodd., 17.
*goiavier*, Scop., 18.
*inornata*, Garnot, 27, 65.
*megarhyncha*, Q. and G., 79.
*obscura*, Gm., 94.
*panayensis*, Scop., 22.
*sandvicensis*, Gm., 94,
*Myiagra albiventris*, Peale, 49.
*castaneiventris*, F. and H., 49.
*rufiventris*, Elliot, 49.
*Myiolestes aruensis*, G. R. Gr., 79.
*phajonotus*, Müll., 65.
*Myristicivora bicolor*, Scop., 7, 8, 23, 71.
*luctuosa*, Reinw., 71.
*melanura*, G. R. Gr., 71.
*spilorrhoa*, G. R. Gr., 71.
*Myzomela boiei*, S. Müll., 66.
*erythrocephala*, Meyer, 80.
*jugularis*, Peale, 45.
*nigrita*, G. R. Gr., 29, 80.
*obscura*, Gould, 89.
*pammelæna*, Scl., 28, 156.

*Napothera elæoides*, Müll., 79.
*Nectarinia auriceps*, G. R. Gr., 61.
*aspasioides*, G. R. Gr., 63.
*australis*, Gould, 89.
*frenata*, Müll., 28, 61, 89.
(*Myzomela*) *boiei*, S. Müll., 66.
*Nectarophila juliæ*, Tweedd., 7, 8, 20, 155.
*Nesocichla eremita*, Gould, 111, 157.
*Nesospiza acunhæ*, Cab., 112, 157.
*Ninox boobook*, Lath., 84, 85.
*Nisus cruentus*, Schleg., 40.
*poliocephalus*, G. R. Gr., 74.
*rufitorques*, Schleg., 40, 41.
*Numenius phæopus*, Linn., 6, 7, 8, 23, 73.
*uropygialis*, Gould, 33, 72, 73, 83.
*Nycticorax americana*, Gould, 106.
*caledonicus*, Lath., 30.
*obscurus*, Bp., 106.

*Oceanites oceanicus*, Kuhl, 141.
*Ochthodromus inornatus*, Gould, 92.
*Œnops falklandica*, Sharpe, 105.
*Œstrelata brevirostris*, Less., 145.
*kidderi*, Coues, 145.
*lessoni*, Garn., 143, 144, 151.
*mollis*, Gould, 113, 144.
*sericea*, Less., 144.
*Oncocarpus vitiensis*, 52, 152.
*Oriolus acrorhynchus*, Vigors, 18.
*flavocinctus*, King, 88.
*viridis*, Lath, 87.
*Orthotomus castaneiceps*, Walden, 6, 19.
*Osmotreron axillaris*, G. R. Gr., 6, 8, 22.
*Ossifraga gigantea*, Gm., 113, 143.
*Otus brachyotus*, Forst., 96.
*Oxyurus spinicauda*, Gm., 102.

*Pachycephala*, sp., Forbes, 84, 86.
*albicollis*, Temm., 60.
*brunnea*, Wall., 65.
*melanura*, Bp., 60.
*mentalis*, Wall., 60.
*nigrimentum*, G. R. Gr., 60.
*phæonota*, Salvad., 65, 157.
*senex*, Pelz., 65.
*torquata*, Layard, 50.
*vitiensis*, Gray, 49, 50.
*Pachyptila banksi*, Smith, 146.
*Pagodroma nivea*, Gm., 142, 144.
*Pandion haliaëtus*, Linn., 30.
*leucocephalus*, Gould, 67.
*solitarius*, Peale, 96.
*Paradisea apoda*, Linn., 81.
*Pelagodroma marina*, Lath., 113, 142.
*Pelargopsis gigantea*, Walden, 6, 7, 8, 12.
*Pelecanoides garnoti*, Less., 146, 151.
*urinatrix*, Gm., 146.
*Pelecanus leucogaster*, Bodd., 119.
*piscator*, Linn., 120.
*Phabotreron brevirostris*, Tweedd., 7, 8, 22, 155.
*leucotis*, 23.
*Phænorhina goliath*, 153, 154.
*Phœornis obscura*, Gm., 94.
*Phaëthon æthereus*, Linn., 118.
*flavirostris*, Brandt, 119.
*Phalacrocorax albiventris*, 121.
*carunculatus*, 120, 121.
*cirrhatus*, Gm., 121.
*imperialis*, King, 120, 121, 122, 158.
*verrucosus*, Cab., 121, 122, 158.
*Phalaropus hyperboreus*, 116.
*Phasianus versicolor*, 117.
*Philemon albitorques*, Scl., 28, 156.
*buceroides*, Swain., 89.
*plumigenis*, G. R. Gr., 70.
*Phœbetria fuliginosa*, Coues, 148.
*Phrygilus gayi*, Eyd. et Gerv., 100.
*melanoderus*, Q. and G., 100.
*Picus lucidus*, Scop., 10.
*Piezorhynchus infelix*, Scl., 27.
*Pinarolestes megarhynchus*, Q. and G., 79, 86.
*rufigaster*, Gould, 86.
*Pionias rhodops*, G. R. Gr., 61, 67.
*Pitlonorhynchus melanotis*, G. R. Gr., 82.
*Pitta erythrogastra*, Temm., 18.
*Platycercus personatus*, G. R. Gr., 42.
*splendens*, Peale, 41, 42.
*Platycercus taviunensis*, Layard, 42.
*Podargus papuensis*, Q. and G., 85.
*Polioaëtus solitarius*, Peale, 96.
*Polyborus tharus*, Mol., 105.
*Porphyrio calvus*, Vieill., 33, 39.
*ellioti*, Salvad., 33.
*indicus*, Scl., 33, 39, 40
*samoënsis*, Peale, 39, 40.
*vitiensis*, Peale, 39.
*Prion banksi*, Smith, 145, 146.
*desolatus*, Gm., 145, 151.
*vittatus*, 145.
*Prioniturus discurus*, Vieill., 7, 9.
*Procellaria æquinoctialis*, Linn., 143.
*antarctica*, Gaim., 142.
*brevirostris*, Less., 145.
*capensis*, Linn., 144.
*cinerea*, Gm., 143.
*desolata*, Gm., 145.
*gigantea*, Gm., 143.
*glacialoides*, Smith, 142.
*grallaria*, Vieill., 141.
*lessoni*, Garn., 144.
*leucogastra*, 142.
*marina*, Lath., 142.
*melanogaster*, 142.
*mollis*, Gould, 144, 145.
*nivea*, Gm., 144.
*oceanica*, Kuhl., 141.
*urinatrix*, Gm., 146.
*Pseudoprion banksi*, Smith, 146.
*desolatus*, Gm., 145.
*Psittacula melanogenia*, Rosenb., 74.
*Psittacus alecto*, Temm., 74.
*capistratus*, G. R. Gr., 67.
*cyanauchen*, Müll., 60.
*discurus*, Vieill., 9.
*domicella*, Linn., 60.
(*Eos*) *bernsteini*, Rosenb., 68.
*fuscicapillus*, Vieill., 61.
*grandis*, Gm., 59.
*lucionensis*, Linn., 9.
*megalorhynchus*, Bodd., 59,
*polychlorus*, Scop., 75.
*rhodops*, G. R. Gr., 61.
*roratus*, Müll., 59.
*Psittirostra psittacea*, Gm., 94.
*Ptilonopus coronulatus*, G. R. Gr., 82.
*dupetit-thouarsi*, 58.
*fasciatus*, 38, 58.

*Ptilonopus iozonus*, G. R. Gr., 82.
*pelewensis*, 58.
*perousei*, 58.
*ponapensis*, 58.
*porphyraceus*, Forst., 38, 58.
*purpuratus*, Gm., 57.
*superbus*, Temm., 90.
*taitensis*, Elliot, 57.
*Ptilopus bellus*, Scl., 32.
*coronulatus*, G. R. Gr., 82.
*ionozonus*, Salvad., 82.
*iozonus*, G. R. Gr., 82.
*johannis*, Scl., 32, 156.
*layardi*, Elliot, 51.
*purpuratus*, Elliot, 38.
*speciosus*, Schl., 32.
*superbus*, Temm., 84, 90.
*victor*, Gould, 51.
*Ptilorhis alberti*, Elliot, 87.
*magnificus*, Gould, 87.
*Ptilotis carunculata*, Gm., 36, 45, 46, 156.
*chrysotis*, Lewin, 88.
*filigera*, Gould, 80, 88.
*lewini*, Swains, 88.
*procerior*, F. and H., 46, 47, 156.
*provocator*, Layard, 47, 156.
*similis*, 46.
*xanthophrys*, Finsch, 47.
*Puffinuria garnoti*, Less., 146.
*Pygarrhicus albigularis*, King, 102.
*Pygosceles tæniatus*, Peale, 124, 132, 152.
*wagleri*, Scl., 124.

*Rallus antarcticus*, King, 108.
*pectoralis*, Gould, 84, 92.
*Rectes aruënsis*, Sharpe, 79.
*dichrous*, G. R. Gr., 79.
*dichrous ceramensis*, Meyer, 79.
*draschi*, Pelz., 79.
*uropygialis*, Gray, 79.
*Rhipidura assimilis*, G. R. Gr., 68.
*griseicauda*, Salvad., 65.
*isura*, Gould, 68.
*rufifrons*, Lath., 27, 65.
*semirubra*, Scl., 27, 156.
*setosa*, Q. and G., 68.
*squamata*, S. Müll., 65, 157.
*Rhynchœa capensis*, Linn., 7, 8, 24.

Sandwich flycatcher, Lath., 94.
*Sauromarptis gaudichaudi*, Q. and G., 77.
*tyro*, G. R. Gr., 77.
*Sauropatis chloris*, Bodd., 6, 8, 13, 65, 76.
*sancta*, Vig. & Horsf., 76.
*Scolopax capensis*, Linn., 24.
*incanus*, Gm., 24.
*phæopus*, Linn., 23.
*stenura*, Kuhl, 24, 64.
*Scops leucospilus*, G. R. Gr., 59.
*morotensis*, Sharpe, 59.
*Scytalopus magellanicus*, Lath., 102.
*Spatula platalea*, Vieill., 107.
*Sphecotheres flaviventris*, Gould, 88.
*Spheniscus magellanicus*, Forst., 124, 125, 126, 129, 152, 158.
*demersus*, Linn., 124, 125, 126, 129, 132, 158.
*humboldti*, Meyen, 126.
*Spiloglaux marmoratus*, Gould, 84, 85.
*Stercorarius antarcticus*, Less., 111, 113, 139, 151.
*chilensis*, Bp., 140.
*pomatorhinus*, Temm., 140.
*Sterna*, sp., 151.
*bergii*, Licht., 8, 25, 34, 135.
*candida*, Gm., 136.
*cassini*, Scl., 134.
*fluviatilis*, 135.
*fuliginosa*, Gm., 136, 151.
*hirundinacea*, Less., 134, 135, 151.
*hybrida*, Pallas, 25, 133.
*macrura*, 135.
*stolida*, Linn., 137, 151.
*vittata*, Gm., 113, 133, 134, 135.
*Strepsilas interpres*, Linn., 33, 84, 92.
*Strix sandwichensis*, Bloxam, 96.
*Sula*, sp., 150.
*cyanops*, Sund., 119, 120.
*leucogastra*, Bodd., 119.
*piscator*, Linn., 120.
*Synœcus cervinus*, Gould, 84, 92.

*Tœnioptera obscura*, Cassin., 94.
*pyrope*, Kittl., 102.
*Tachyeres cinereus*, Gm., 107.
*Talegalla lathami*, Gray, 91.
*Tanygnathus lucionensis*, Linn., 7, 8, 9.
*megalorhynchus*, Bodd., 59.
*Tardus armillarus*, Temm., 60.
*Terekia cinerea*, 117.
*Thalassidroma leucogastra*, Gould, 141.

*Thalassidroma melanogastra*, Gould, 142, 151.
*segethi*, Phil. et Landb., 141, 142.
*tropica*, Gould, 142.
*Thalasiœca glacialoides*, Smith, 142.
*antarctica*, Gaim., 142.
*Theristicus melanopis*, Gm., 106.
*Tinnunculus cinnamominus*, Swain, 105.
*dominicensis*, 105.
*isabellinus*, 105.
*leucophrys*, 105.
*sparverioides*, 105.
*sparverius*, Linn., 104, 105.
*Todirhamphus sanctus*, Vig. and Hors, 84, 85.
*vitiensis*, Cass., 44.
*Totanus glareola*, Linn., 61.
*griseopygius*, Gould, 92.
*incanus*, Gm., 7, 8, 24, 33, 84, 92, 99.
*pulverulentus*, Müll., 92.
*Trichoglossus cyanogrammus*, Wagl., 30, 75, 76, 116.
*massenæ*, 76.
*multicolor*, Gould, 90.
*nigrigularis*, G. R. Gr., 75, 76, 157.
*swainsoni*, Gould, 90.
*Treron axillaris*, G. R. Gr., 22.
*Tringa fuscicollis*, Vieill, 109.
*hypoleucos*, Linn., 24.
*Tringoides hypoleucos*, Linn., 6, 7, 8, 24, 33, 64, 72, 83.
*Trogon ardens*, Temm., 11.
*Tropidorhynchus buceroides*, Swain., 89.
*plumigenis*, G. R. Gr., 70.
*Turdus falklandicus*, Q. and G., 100.
*guianensis*, Carm., 111.
*mandarinus*, Bp., 114.
*merula*, 112.
*philippinensis*, Gm., 19.
*Turnix maculosus*, Temm., 114.
*melanota*, Gould, 91.

*Urospiza poliocephalus*, G. R. Gr., 74.
*spilothorax*, Salvad., 74.
*Urospizias iogaster*, S. Müll., 61.
*poliocephalus*, G. R. Gr., 74.

*Vanellus cayennensis*, Scl., 108.
*occidentalis*, Harting, 188.
*Vultur atratus*, 105.
*aura*, 105.
*papa*, 105.

*Xanthotis chrysotis*, Less., 80.
*fitigera*, Gould, 80.

*Zonotrichia canicapilla*, Gould, 101.
*pileata*, 101.
*Zosterops chloris*, S. Müll., 66.
*explorator*, Layard, 48, 156.
*flaviceps*, Peale, 48, 156.
*intermedia*, Wall., 66.
*luteus*, Gould, 84, 89.
*westernensis*, Q. and G., 48.
*xanthochroa*, Gray, 49.

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LORICULUS PANAYENSIS, 1 ♂. 2 ♀.

Hanhart imp

Smit del et lith.

Hanhart imp.

BATRACHOSTOMUS SEPTIMUS.

BUCEROS MINDANENSIS.

DICRURUS STRIATUS

. del et lith

1. DICÆUM MINDANENSE. 2,3 NECTAROPHILA JULIÆ. ♂ ♀

Smit del et lith.

PHABOTRERON BREVIROSTRIS

J.Smit del. et lith.

Hanhart

1. MONARCHA INFELIX. 2. RHIPIDURA SEMIRUBRA
3. MYZOMELA PAMMELÆNA

PHILEMON ALBITORQUES.

J. Smit del. et lith

CARPOPHAGA RHODINOLÆMA.

Hanhart imp.

Smit del. et lith.

PTILOPUS JOHANNIS ♂ et ♀.

J.Smit del et lith

MEGAPODIUS EREMITA

Hanhart imp

Smit del et lith

1 PTILOTIS CARUNCULATA
2 " PROCERIOR

J.Smit del. et lith.

Hanhart imp.

1. PTILOTIS PROVOCATOR
2. " " jr

Smit del. et lith.

1. ZOSTEROPS FLAVICEPS.
2. " EXPLORATOR.

Smit. del et lith.

Hanhart imp

CHRYSŒNAS VICTOR . ♂

Smit del. et lith.

CHRYSŒNAS VIRIDIS. 5

CARPOPHACA LATRANS.

J. Smit, del. et lith.

1. PACHYCEPHALA PHÆONOTA. 2. RHIPIDURA SQUAMATA

GRAUCALUS POLLENS.

J.Smit del. et lith. Lanhart imp.

TRICHOGLOSSUS NIGRIGULARIS.

J.Smit del. et lith.

BUTEO SOLITARIUS.

Hanhart imp

ANAS WYVILLIANA.

J.Smit del. et lith

NESOSPIZA ACUNHÆ.

Hanhart imp

Smit del. et lith.

Hanhart imp

1. PHALACROCORAX IMPERIALIS.
2. " ALBIVENTRIS.

Smit del. et lith.

1. PHALACROCORAX VERRUCOSUS, ♂.
2. " " , jr.

Hanhart imp

3

J.Smit del. et lith.

SPHENISCUS DEMERSUS.

Hanhart imp

1
3

J. Green del. et lith.

1. SPHENISCUS MAGELLANICUS.
2. " " jr.

J Smit del. et lith. Hanhart imp.

1. EUDYPTES CHRYSOLOPHUS.
2. " " , pale variety

J.Smit del et lith

Hanhart imp

1. EUDYPTES CHRYSOCOME.
2. " " ,pull

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